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BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

DIVISION OF INSECTICIDE INVESTIGATIONS

THE HISTORY OF THE USE OF DERRIS AS AN INSECTIDE.

PART II--THE PERIOD 1919-1928

By

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Contents

Introduction

In a previous paper, The Early History (1848-1918) of the Use of Derris as an Insecticide (82)[1], the writer reviewed the history of the use of derris as an insecticide from 1848 to 1913, inclusive, which is the period from the time of the first account in English of the insecticidal use of derris to the time immediately preceding the publication of the work of McIndoo, Sievers, and Abbott, investigators of the United States Department of Agriculture. The 10-year period 1919-28 witnessed great activity in the exploration of the insecticidal uses of derris. Bishopp and associates worked out the control of Hypoderma larvae in the backs of cattle by the application of powders, washes, or ointments containing derris. Investigators in England and Canada published the results of tests of derris against many insects. Proprietary insecticides of British manufacture that contained derris powder or derris extract became more widely known and received mention in entomological literature. However, in this literature no mention is found of rotenone or the other active principles of derris. The derris used by different investigators varied widely in toxic content, and hence it is not surprising to find contradictory statements regarding the value of derris for the control of certain pests. Derris was not a regular article of commerce in the United States. No method of chemically evaluating it was known. In view of these facts it is not surprising that derris did not really come into its own until the results of the investigations of chemists on the active principles of derris and their analytical determination were published. This was not until after 1928.

In the present paper the writer has endeavored to present an account of all work with derris against specific insects that was published during the 10 years 1919 to 1928, inclusive. As nearly as possible the work of the various investigators is given in chronological order. A summary of the 10 years' research is given in tables. Table 1 gives information concerning the effectiveness of each derris preparation tested against each insect, with a reference to the original article. The insects in table 1 are arranged according to family under the appropriate order. In table 2 all insects are listed alphabetically according to genus, and information is given concerning the common name, the order, and the family of each species. In table 3 is given an alphabetical list of the common names of the insects together with the corresponding scientific names. It is believed that the reader may readily obtain the information he seeks by reference to one or more of these tables.

Throughout this publication the term "gallon" is understood to mean the standard United States gallon of 231 cubic inches. The gallon referred to in British publications is the imperial gallon of 277.27384 cubic inches.

An imperial gallon equals about 1.2 United States gallons, and conversely a United States gallon equals about 0.83 imperial gallon.

1/ Not available for distribution.

1919

McIndoo, Sievers, and Abbott (66) in 1919 reported an extensive study of derris as an insecticide. The following is a list of the material used and the sources from which and through which it was secured: Powdered roots of a species of Derris, most likely Derris elliptica Benth., from the open market where it is sold as an insecticide; roots of D. elliptica, called "tuba" or "toeba" in the Dutch East Indies, from the 's Lands Plantentuin, Buitenzorg, Java; stems of D. uliginosa Benth., from C. H. Knowles, Suva, Fiji Islands; stems of D. koolgiberah Baill. and of D. oligosperma, from the director of the Botanical Gardens at Brisbane, Queensland, Australia; roots of D. scandens Benth.; and stems and roots of D. robusta Benth., from the director of the Botanical Survey of Sibpur, Calcutta, India.

The authors' conclusions are as follows: Derris powder dusted upon insects does not pass into the tracheae, but a limited amount of it may lodge in the spiracles, though never sufficiently to interfere with breathing. In order that the vapors and exhalation from a nicotine-spray solution be effective, it is necessary for the insects sprayed to carry some of this solution on their bodies; likewise it is necessary for the insects dusted with derris powder to carry some of this powder on their bodies in order that its exhalation may pass into the spiracles in as undiluted a condition as possible. After being dusted the insects seem to swallow some of the powder, which later may act as a stomach poison. Soap solutions containing derris extracts pass freely into the spiracles and finally reach the various tissues, but probably the extracts kill by first affecting the nerve tissue.

Derris acts both as a contact insecticide and as a stomach poison, but is of no practical value as a fumigant. Six species of derris were tested, but only two of them (elliptica and uliginosa) were found to be satisfactory for insecticidal purposes.

The toxic principle in derris kills some insects easily and others with difficulty, but it usually acts slowly and seems to kill by motor paralysis.

Derris powder, used as a dust under practical conditions, was found to be efficient against dog fleas, chicken lice, house flies, three species of sphids (Aphis rumicis L., A. pomi Degeer, and Myzus persicae Sulz.), potato-beetle larvae, and small fall webworms, but of no practical value against bedbugs, roaches, chicken mites, mealybugs, Orthezia insigni Dougl., red spiders, or the crawling young of the oyster-shell scale. Used as powder in water with or without soap under practical conditions, it proved to be efficient against most of the aphids sprayed and also against cabbage worms, Autographa brassicae Riley, the larvae of apple datanas, Datana ministra Drury, oak worms, Anisota senatoria A. and S., small tent caterpillars, and potato-beetle larvae.

Fine derris powder was extracted successively with five solvents, namely, petroleum ether, ether, chloroform, alcohol, and water, in five different sequences. Water used as the primary solvent extracted 10.80 percent of the material. The extracts and the mares were added to honey and fed to honey bees, Apis mellifera L. The extracts were dissolved in alcohol (0.4 gram in 10 cc. of 95-percent alcohol), and 1/4 cc. of this solution was mixed with 5 cc. of honey. The water extract had no effect on the bees tested and the powder exhausted with water killed 94 percent of the bees within 48 hours. All the other extracts, whether obtained with the use of heat or without it, were almost equally toxic to honey bees.

Similar results were obtained by using the same extracts against aphids, fall webworms, Hyphantria cunea Drury, and tussock-moth caterpillars, Hemerocampa leucostigma A. and S. The filtered water extract from the powder of derris killed only a small percentage of the aphids sprayed, while the non-filtered spray mixtures, consisting of powder and soap solution, were efficient against aphids. The powders exhausted with ether, chloroform, and alcohol had very little effect on bees (1/8 gram of powder mixed with 5 cc. of honey).

To determine whether any poisonous volatile substance can be removed from derris by steam distillation, 50 grams of the powder were so treated and the distillate collected. Later some of this distillate and a portion of the distilled powder, after it had been dried, were tested on silkworms. The distillate had no effect whatever, but the powder was as poisonous as ever.

Various species of derris (roots and stems) were extracted with hot denatured alcohol. The percentage of extract ranged from 8.5 to 22.5 percent.

Yellowish-white platelike crystals, m. p. 170° C., [probably impure rotenone] were obtained by extracting derris root with boiling water according to the procedure of Van Sillevoldt.

A dilute alcoholic solution of these crystals, as well as the alcoholic solution of the resin from which the crystals had been separated, was found to be very toxic to fish. A subcutaneous injection of 0.66 mg. of the crystals was fatal to a mouse in 2 hours.

Resinous materials obtained by alcoholic extraction of the roots were tested on chinook salmon and found to be exceedingly toxic. When sprayed on foliage these resins killed from 54.4 to 92.3 percent of small tent caterpillars.

The roots of tuba were ground as fine as their fibrous nature would permit, and 200 gm. of this powder were macerated for 2 days with a quantity of cold water. After the mixture had been filtered, the water extract measured 600 cc., each cc. representing 1/3 gm. of the roots. Half of this cold-water extract was tested on small tent caterpillars; within 8 days only 30.9 percent of them had died.

Tests with alcoholic extracts and powders are also recorded against Macrosiphum liriodendri Mon., Macrosiphum (Illinoia) sp., Aphis helianthi Mon., Rhopalosiphum pseudobrassicae Davis, Aphis gossypii Glover, and Aphis spiraecola Patch.

Derris was applied as a powder against various insects with the following results:

Dog fleas: Eight dogs badly infested with fleas, Ctenocephalides canis Curt., were dusted thoroughly. The material was applied with a shaker and well rubbed into the hair with the hands. At the end of 48 hours no living fleas were observed. Several dead ones were seen still clinging to the hairs.

Chicken lice: Twelve hens badly infested with several species of lice (Mallophaga) were thoroughly treated with the powder, which was well rubbed in through the feathers. When the hens were examined 2 or 3 days later they were free from lice.

Chicken mites: When this powder was freely dusted over the chicken mites, Dermanyssus gallinae Degeer, confined in jars, all were killed within 24 hours, but when used under practical conditions in a badly infested chicken house all the mites were not killed.

Bedbugs: Derris was tested against bedbugs, Cimex lectularius L., by placing 20 bugs in a jar with a quantity of excelsior and then thoroughly dusting the contents of the jar. In nine tests under these very severe conditions 24.4 percent of the bugs were killed in 24 hours and 52.8 percent in 4 days. This material would be of no practical value against bedbugs.

Roaches: Six small cages were thoroughly dusted and 20 roaches, Blattella germanica L., were placed in each cage. At the end of one week an average of 57.5 percent of the roaches were dead, which indicates that this material would be of very little value under practical conditions.

House flies: In cage tests, where house flies, Musca domestica L., were dusted in ordinary flytraps about 10 inches high, all were dead or inactive within 24 hours. In room tests, where the powder was freely blown into the air and all parts of the room with a small hand dust gun, all the flies were dead at the end of 16 hours. In one test several hundred flies were liberated in a room which had been thoroughly dusted 7 days before. Twenty-four hours later very few active flies were to be seen, and on the second day only three or four were living.

Plant insects: Derris applied as a dust was of no value against the mealybug Pseudococcus citri Risso, the greenhouse orthezia, Orthezia insignis Dougl., red spiders, Tetranychus bimaculatus Harv., and the crawling young of the oystershell scale, Lepidosaphes ulmi L.; but it was effective against nasturtium aphids, Aphis rumicis L., and the green apple aphid, Aphis pomi Degeer.

Derris, even at the rate of 1 pound to 200 gallons of water, was very effective against the green apple aphid under field conditions. On apple foliage the addition of soap does not increase its effectiveness. This powder is also effective as a dust.

Under greenhouse conditions, in tests against the nasturtium aphid, this material was found to be effective when used at the rate of 1 pound of powder to 400 gallons of water, with soap at the rate of 1 pound to 100 gallons.

Oyster-shell scale: At the rate of 1 pound of powder to 20 gallons of water, either with or without soap in the proportion of 1 pound to 100 gallons, derris was ineffective against the crawling young of the oyster-shell scale, Lepidosaphes ulmi L.

The efficiency of derris as a stomach poison against various insects was also tested.

Potato beetle larvae: Derris powder as a stomach poison was tested on a small scale against potato beetle larvae, Leptinotarsa decemlineata Say, at several strengths, ranging from 1 pound of powder to 16 gallons of water up to 1 pound to 128 gallons and was found to be very effective. Practically all the larvae were killed within 48 hours and the plants were little eaten.

Since these spray mixtures might have acted as contact poisons, because the larvae were already on the plants when the latter were sprayed, a second series of tests was arranged to eliminate this factor. The same plants were used and from 20 to 40 larvae were placed on them 1 or 3 days after they had been sprayed. The results obtained were practically the same as in the first series of tests. Very few living larvae were found three days later and the plants were little eaten. When applied as a dust, derris was equally efficient against potato beetle larvae.

Tent caterpillars: Derris was tested against young tent caterpillars, Malacosoma americana F., in a series of strengths ranging from 1 pound of powder to 8 gallons of water to 1 pound to 200 gallons. All the mixtures were found to be effective. Apple-tree branches were thoroughly sprayed, and after the foliage had dried 20 to 40 newly hatched larvae were placed on each branch. The caterpillars began to show signs of discomfort within 48 hours and were practically all dead in from 5 to 10 days. In no case was any material amount to feeding observed.

In a second series of tests the larvae were placed on the branches and spraved after they had begun to form their tents. Under these conditions sprays containing 1 pound of powder to 50 gallons of water and 1 pound to 100 gallons killed all the larvae within 24 hours. When 1 pound to 200 gallons and 1 pound to 400 gallons were used, all the larvae were not killed within 11 days, but the few which remained alive were very small and inactive. Used as a dust, this material killed all the treated larvae within 1 week.

Fall webworms: These caterpillars, Hyphantria cunea Drury, about one-third grown, were killed within a week by a spray containing 1 pound of powder to 5 gallons of water. Mixtures ranging from 1 pound to 50 gallons to 1 pound to 200 gallons were not satisfactorily effective, since nearly all the sprayed foliage was eaten and not all the caterpillars were killed.

Oak worms: Two small oak trees, on which about 300 caterpillars of Anisota senatoria A. and S., were feeding, were spraved thoroughly with derris at the rate of 1 pound of powder to 25 gallons of water; soap was added at the rate of 1 pound to 50 gallons, and a knapsack sprayer was used. Within 24 hours the larvae became inactive and ceased to feed, and at the end of 6 days no living ones could be found. As a check on this test, powdered lead arsenate was applied at the rate of 1 pound to 50 gallons of water, and almost identical results were obtained.

A second test was made in which a small tree was sprayed, and 24 hours later about 50 larvae were placed on it. The caterpillars ate very little and gradually disappeared, evidently leaving the tree, since no dead ones were observed; and at the end of 5 days they were nearly all gone.

Datana larvae: Two apple trees, on which large colonies of nearly full grown apple datanas, Datana ministra Drury, were feeding, were sprayed with derris at the rate of 1 pound of powder to 50 gallons of water. Twenty-four hours later one living larva was found one one tree and two on the other. The ground under the trees was thickly sprinkled with dead larvae and many had lodged in the trees.

Cabbage worms: In two cage tests against cabbage loopers, Autographa brassicae Riley, derris, applied at the rate of 1 pound to 25 gallons of water, killed all the larvae within 24 hours.

Howard (97), in his 1919 annual report as Chief of the Bureau of Entomology, United States Department of Agriculture, stated that if derris can be obtained in sufficient quantities, it will prove an important addition to our list of substances that kill soft-bodied insects, such as plant lice.

Roark (81) in 1919 included Derris elliptica and D. uliginosa in a list of insecticidal plants.

1920

Mathieu (62) in 1920 reported the control of Agromyza phaseoli Coq. attacking young beans, with derris.

> "A trial of tuba was made on a field of 8 beds, 66 feet long, with 1,056 seeds of Lima Bean (Small Sieva) on the 28th of October, 1919. Ten ounces of tuba-root were well pounded in a wooden mortar, the juice was thoroughly expressed, and the fiber exhausted in 20 imperial gallons of water. Tuba-water was then applied to

each young plant at the rate of a cigarette tin full to 4 plants, morning and evening. This was continued for 15 days, until the plants were sufficiently established to be past all danger, which is only present during the first stage of their existence, when the stem is quite tender. Only 16 seeds failed to germinate, and of the 1,040 plants that came up, not one has since died. And today the plot is showing the most vigorous growth, a living testimony to the potency of the tuba-root as a plant-insect killer."

Lloyd (59) in 1920 reported tests of preparations of tuba root (derris) against larvae of the glasshouse tomato moth, Polia oleracea L., (1) as a dry dust, alone and in dilution with powdered earth; (2) with saponin in water suspensions, at various strengths from 0.25 percent to 10 percent by weight of the powdered root, mixed and strained through muslin; (3) with saponin in water suspensions of an alcoholic extract (six times the strength of the powdered root), at various strengths from 0.08 percent to 2 percent by weight. These derris preparations were made by Tattersfield.

Tomato plants in pots were dusted or sprayed with these and infested with larvae collected in nurseries. The dusting was unsatisfactory, as it made the plants dirty and encouraged the growth of molds. The water suspensions of the powdered root killed the larvae at a 10-percent strength, but a 5-percent strength failed to do so within a reasonable time. These strong mixtures also dirtied the foliage. Suspensions of the alcholic extract proved very satisfactory sprays on an experimental scale. A series of 18 experiments showed that 1 part of this substance by weight in 1,000 parts of water is a sufficiently potent spray. A plant sprayed with this was infested with 12 half-grown larvae which were confined to one leaf by means of a sleeve. Two days later 7 of these were dead, and 8 days after they were put on they were all dead. Ten more half-grown larvae were then placed on another leaf, and 10 days later all these were dead. The spray therefore remained potent for 20 days. The foliage of the plant was not damaged, and the fruit set normally. This plant at the end of the experiment was photographed with a control plant of the same age which, without spraying, was infested with 10 half-grown larvae at the time the second lot was released on the sprayed plant. They completely ate a leaf each day and had destroyed the plant by the time those on the protected one were all dead. Similar experiments were carried out with strengths of 5, 2-1/2, 1-2/3, 1-1/4, and 5/8 pound of the alcoholic extract in 100 imperial gallons of water, respectively, and each plant was infested with 22 larvae as described above. The results varied little from those detailed, except that with the weakest strength the death rate was somewhat slower. None of the plants were damaged, and the substance appears to be safe to use, but no large-scale experiments were carried out.

Flippance (32) in 1920 suggested tuba-root (derris) powder for combating various small beetles attacking palms in the Straits Settlements, also for use against the larvae of the large coconut butterfly, Amathusia phidippua L., and the larvae of Erionota thrax L.

The Federated Malay States Department of Agriculture (28) in 1920 reported that in Perak, during October and November, experiments were conducted on the control of Bena Kura, Podops coarctata F., a medium-sized brown bug; stem borers, Schoenobius bipunctiferus Wolk. and other species; and the mole cricket, Gryllotalpa sp. Spraying with kerosene emulsion and extract of tuba root (Derris sp.) were tried. The results were uncertain.

1921

Symes (88) in 1921 reported that pure derris powder applied to a bed of mushrooms infested with the mushroom fly, Sciara praecox Meig., cleared the bed of insects in 2 or 3 days, but had no effect upon Hypomyces fungi. It is concluded that mushrooms will not stand treatment with powder insecticides (such as pyrethrum, derris, and 1-percent paradichlorobenzene). When not checked in their growth by these powders, the mushrooms are rendered absolutely unfit for market.

Parrott, Glasgow, and MacLeod (76) in 1921 reported tests with a number of materials against two species of plant bugs, namely, the bright red bug, Lygidea mendax Reuter, and the dark red bug, Heterocordylus malinus Reuter. A derris-soap compound was used, a commercial preparation [Derrisol?] assumed to contain approximately one-half pound of powdered derris root and 6 pounds of soap per United States gallon. This derris-soap mixture was used at the rate of 10 pounds to 100 gallons of water. Applied at the rate of 13-1/3 gallons per tree, the derris-soap mixture killed 99.2 percent of the insects. This same mixture, in three different tests, injured 6, 6.3, and 14.1 percent of the apples, the average being 13.2 percent.

Smith and Wadsworth (86) in 1921 tested insecticides upon carrot and onion flies. Four applications of a powder composed of soot and derris at the rate of 1 ounce derris plus 2 ounces soot per square yard resulted in 95 percent clean carrots. The control plot yielded only 20 percent carrots free from infestation by the carrot fly, Psila rosae F. This derris mixture gave the best control of any of the materials tried. Used against the onion flies, Hylemya antiqua Meig., in the same way, six applications of derris-soot mixture (2 parts soot and 1 part derris) at the rate of 1 ounce per square yard gave 60 percent clean onions, whereas soot alone gave only 16 percent clean onions.

Howard (98) in 1921 reported briefly that a study had been made of the insecticidal constituents of plants, and 180 different preparations had been made from 46 different kinds of plants, excluding tobacco, quassia, and derris, the properties of these being generally acknowledged. Of the 180 preparations, only a few were worth further study.

Brittain (11) in 1921 described experiments in which a 50-50 mixture of derris with clay and derris solution at two strengths (1-1/2 and 3 pounds to 100 imperial gallons) were applied to cabbage plants for the control of the cabbage maggot, Chortophila brassicae Bouché. The clay-derris mixture was applied at the rate of 960 pounds per acre. The derris solutions were applied at the rate of 10 and 20 pounds of derris with 650 imperial gallons of water per acre. All the derris

treatments protected the plants. Pure derris powder applied to cabbage plants destroyed 4 percent of the plants in two tests. Derris (3 pounds to 100 imperial gallons) poured about plants previously infested with 25 fully grown cabbage maggots of the first brood prevented none of the larvae from pupating. Onion maggot larvae, Hylemya antiqua Meig., immersed for 5 seconds in derris solution (3 pounds derris to 100 imperial gallons) and then allowed to remain unmolested 1 week upon the food plant were affected as follows:

Age of larvae	Percentage dead or missing in 1 week	Age of larvae	Percentage dead or missing in 1 week
1 day	100	10 days	35
4 days	100	15 days	25
7 days	100	Full grown	0

1922

Treherne (95) in 1922 suggested the separation of the essential oils or extracts of plants in order to prepare liquid sprays or medicated powders which would act negatively chemotropically in insect pests, as has been done with tobacco, pyrethrum, hellebore, derris, and certain other substances.

The Federated Malay States Department of Agriculture (29) in 1922 reported that for dealing with the pest Nymphula depunctalis Guen. in the padi nurseries spraying was being carried out with a decoction of tuba root.

Bishopp, Laake, and Wells (7) in 1922 stated that a single application of derris in soapy water applied with a brush to the backs of infested animals had been found to kill almost 100 percent of Hypoderma larvae.

Wells, Bishopp, and Laake (109) in 1922 reported the results of tests of powdered derris root against certain external parasites of animals. When chickens infested with 7 species of lice (Mallophaga) were rather thoroughly dusted with derris the lice were very quickly destroyed, practically all of them being dead the day following treatment. Subsequent examinations extending over a period of 6 weeks showed no live lice present, thus indicating that the eggs were killed or the young lice destroyed upon hatching. All lice were killed 3 days after dipping fowls in a bath of 1/4 ounce of powdered derris in 1 gallon of water.

Derris proved effective against the common biting louse of cattle, Bovicola bovis L. Derris powder, 1 ounce per animal, applied with a dust gun killed all lice and their eggs. A mixture of derris with an equal quantity of flour applied at the rate of 1 ounce or 1.5 ounces per animal also killed all lice and their eggs. A mixture of equal parts of derris and sodium fluoride dusted on calves at the rate of 1-3/16 ounces per animal killed all lice. A mixture of equal parts of derris and tobacco dust, the latter containing about 0.1 percent nicotine, killed all adult lice, but some of the eggs escaped destruction. Mixtures of derris, 1 part, and tobacco dust, 10 parts; and of derris, 1 part, and flour, 3, 5, 10, or 20 parts, killed most but not all of the lice.

Pure derris powder and a 1 to 1 mixture of derris and flour, applied with a shaker, about 1 ounce per animal, killed all sucking lice, Linognathus vituli L., on calves. Mixtures of derris with flour, 1 to 5, 1 to 10, and 1 to 20, killed all but a few of the lice. A mixture of equal parts of derris and sodium fluoride killed all lice, L. vituli, and their eggs.

Calves infested with Solenoptes capillatus End. were dusted with mixtures of derris with flour, 1 to 1, 1 to 5, 1 to 10, and 1 to 20. The 1-to-1 mixture, 1-3/4 ounces per animal, killed all lice, but the weaker mixtures were not 100 percent effective.

All sucking lice, Linognathus piliferus Burm., and their eggs on a dog were killed by 2 grams of a mixture of 1 part derris and 3 parts corn starch; also with a 1-to-1 mixture of derris and flour.

An ointment consisting of 1 part of derris to 2 parts of vaseline applied to the holes of warbles in the backs of cattle proved as effective as any other material used in this way. Five days after treatment all grubs were found to have been killed and the condition of the cysts was very satisfactory. A wash consisting of 1 pound of derris, 4 ounces of soap, and 1 gallon of water applied once with a brush to the backs of infested cattle killed practically all grubs.

A series of tests with several breeds of dogs indicated that the minimum dosage necessary to destroy all flease completely was 0.87 gram of a mixture of equal parts derris and corn starch per animal. When the quantity of derris was reduced to 0.2 gram 100 percent kill was not realized. Following these preliminary experiments, a mixture of derris and corn starch, in the proportion of 1 to 3, was applied to all the animals in the hospital at the time--48 dogs and 9 cats. The material was put on along the back and neck of each animal with the thumb and finger. An average of slightly less than 2 grams per animal was applied. These animals were treated on December 4, and subsequent examinations up to December 10 showed no living fleas. Both dog and cat fleas--Ctenocephalides canis and C. felis--were present.

In one test puppies rather heavily infested with the sticktight flea, Echidnophaga gallinacea, as well as the dog and cat fleas, were each treated with one gram of undiluted derris. In a few hours dead dog and cat fleas began dropping off the hosts and thefollowing day all specimens were dead, though many sticktights remained attached.

The authors concluded:

> "Derris powder is satisfactory as a destroyer of Mallophaga on chickens and cattle, but apparently not quite as effective on the latter as sodium fluoride.
>
> "It is very effective against Anoplura on cattle and dogs, one treatment accomplishing the destruction of all stages.

"The results of its use against fleas on dogs and cats are probably most striking, very small amounts being sufficient to destroy all fleas present.

"It appears to be effective for lice and fleas when reduced with from one to ten parts of a carrier to one part of derris."

Brittain (12) in 1922 reported that when derris (3 pounds to 100 emperial gallons of water) was applied to cabbage plants (Copenhagen Market variety), 39 percent of the plants were destroyed by maggots. In another test 2 pounds of derris to 100 imperial gallons of water permitted about 29 percent of the plants (Early Jersey Wakefield variety) to be destroyed. Tests in which 3 pounds of derris to 100 imperial gallons were used permitted from 45 to 80 percent of the plants (Early Jersey Wakefield variety) to be destroyed by maggots. On radishes, derris (3 pounds to 100 imperial gallons) allowed 71 percent of the plants to be infested with cabbage maggots. Corrosive sublimate was the only treatment that gave satisfactory control. Only one material, derris, proved very ineffective. As it was from the same lot of material used the previous year with fair results, Brittain assumed that it had deteriorated in storage. About two-fifths pint of liquid and five-ninths ounce of dust was applied per plant.

De Bussy (14) in 1922 reported the results of tests of various materials upon the larvae of Prodenia litura F. This lepidopterous insect is of great importance in relation to tobacco culture in Deli. The finely ground root of Derris elliptica (toeba) was used as a decoction in water up to 10 grams per 100 cc. yet in no case killed more than 2 out of 5 half-grown caterpillars.

Gilmer (44) in the 1922 report of the Minnesota State Entomologist reported tests made with derris powder furnished by the American Tobacco By-Products and Chemical Corporation, of Louisville, Ky.; also with a derris extract said to contain 16 percent of active derris and 84 percent of inert substances, apparently pyridine. Both these products were manufactured by a British company. The tests included the following mixtures: (1) derris powder 10 percent, tobacco dust 90 percent; (2) derris powder 7-1/2 percent, tobacco dust 92-1/2 percent; (3) derris powder 100 percent, tobacco dust 0 percent; (4) derris powder 20 percent, tobacco dust 80 percent; (5) derris powder 7-1/2 percent, tobacco dust 67-1/2 percent, powdered sulphur 25 percent.

The experiments were of two general types, those performed with the derris powder as furnished, and those with the liquid derris extract. The tests were made on cats, dogs, white rats, and chickens; fleas, lice, chicken lice, and cockroaches. The fleas included the rat flea, Ceratophyllus fasciatus Bosc., and the dog and cat fleas, Ctenocephalides canis Curt. and C. felis Bouche'. The chicken lice included both the body louse, Menopon biseriatum Piaget, and the head louse, Lipeurus heterographus Nitzsch. The rat louse, Polyplax spinulosus Burm., was the common louse of these animals. The cockroaches included the American roach, Periplaneta americana L., and the croton bug, Blatella germanica L.

From the experiments it is concluded that derris furnishes a very efficient insecticide, particularly when used as a powder, against ectoparasites. It is effective, easily applied, not repugnant to the animal or man, and retains its insecticidal properties unaltered in the open air. It should be used about the same as pyrethrum powder, and in the 20 percent derris-80 percent tobacco dust mixture has a killing power about as effective as that of commercial pyrethrum. Its stability in insecticidal power makes it superior to pyrethrum even at a slightly higher price. It seems, however, to lack the instantaneous effect of pyrethrum and is not effective against flies when blown into the air. As a check against roaches, ants, and insect ectoparasites, it is fully the equal of pyrethrum as ordinarily purchased.

The 20 percent derris-80 percent tobacco dust mixture was effective but slow in action against roaches. Roaches forced to run through the powder and then confined in cages or small glass jars all died with 24 hours. These roaches were forced to run over a considerable depth of the powder and were thoroughly coated with it. The powder was also mixed with flour and a little sugar, and roaches were allowed to feed upon it. It proved an effective stomach poison, killing all the roaches experimented upon.

Howard (99) in 1922 called attention to the work of Bishopp and associates, who found derris to be very effective for use in the dust form against lice of cattle and other domestic animals as well as against fleas.

Jack and Sands (53) in 1922 reported that spraying with tuba mixtures is one of the means recommended for controlling the cotton stainer.

1923

Lewin (57) in 1923 wrote that in Sumatra the diluted root sap of Derris elliptica is used to kill caterpillars on young tobacco plants, but too great a quantity kills the tobacco.

Hadwen (48) in 1923 referred to the method of killing Hypoderma larvae by the application to the warble holes of ointments containing iodoform or derris.

Jack (52) in 1923 wrote that the juice extracted from Derris elliptica is most effective in combating the stem-boring insects attacking rice, Schoenobius bipunctiferus and Diatraea auricilia, but can be used only where the padi is grown in water which is not mixed later with the drinking supply.

According to Gimlette (45), writing in 1923, H. E. Durham in 1902 commenced a series of experiments with tuba as a larvicide in the Federated Malay States. Dr. Durham found that the most sensitive animals are perhaps the daphnid crustacea. Tadpoles and water-snails are also easily killed. Caterpillars are easily poisoned; specially sensitive is the gooseberry

saw-fly, Nematus (Pteronidea) ribessi Scop., but Durham found that it had no effect as a contact poison on the black bean aphid, A. rumicis L., and the woolly aphid of the apple, Eriosoma lanigerum Hausm. Trial on frogs' hearts showed that the vagus was paralysed, so that stimulation of the nerve failed to cause the normal vagus inhibition. In England Durham found that Culicid larvae, Theobaldia annulata, were killed in a 1-in-40,000 suspension of the dried powdered crude root of D. elliptica. A solution of 1 in 10,000 killed the larvae in 29 hours and the pupae in from 24 hours to 3 or 4 days. Another experiment with the larvae of Culex pipiens showed that they died in less than 16 hours (pupae in less than 24 hours) with solutions of 1 in 1,000, 1 in 2,000 and 1 in 5,000 of the whole root; with 1 in 10,000 the larvae were killed in 20 hours and the pupae in 24 hours. A solution of 1 in 1,000 of the extract is enough to make the water cloudy.

The California Agricultural Experiment Station (16) in 1923 reported the results of spraying and dusting tests with derris made by L. T. White, under the direction of E. R. de Ong. A dust made from ground derris root mixed with 80 percent of inert carrier was found to give perfect control of the biting lice Menopon biseriatum Piaget and Goniocotes gigas Taschenberg of the fowl; and of the sucking lice Gyropus ovalis Nitzsch and Gliricola porcelli L. of the guinea pig.

Fryer, Stenton, Tattersfield, and Roach (33) in 1923 reported an investigation in which extracts of Derris elliptica were shown to have a high insecticidal value, particularly for caterpillars. They were not so toxic to aphids.

The dry root itself may be used in a finely powdered condition worked up with water together with soap or other emulsifying reagents. As the pure poisons found in derris root are solids and only slightly soluble in water, their toxicity appears to depend upon the degree of dispersion.

A biological method of determining insecticidal properties quantitatively is described. It depends on dipping insects, for a constant period of time (10 seconds), in known strengths of highly dispersed suspensoids in dilute aqueous solutions of saponin. Results agreeing with those given by the chemical method already described were obtained. It enabled the authors to compare extracts of derris with nicotine. To certain caterpillars tubatoxin and derrid are shown to be of the same order of toxicity as nicotine. These conclusions are based on tests with the following insects: Caterpillars of the cabbage white butterfly, Pieris brassicae L., the lackey moth, Malacosma neustria L., the buff-tip, Phalera bucephala L. the gooseberry sawfly, Nematus (Pteronidea) ribesii Scop., and those of another sawfly, Phymatocera aterrima Klug. Tests were also made with larvae of the tomato moth, Polia oleracea L., with silkworms, Bombyx mori L. and with Aphis rumicis L.

Howard (100) in 1923 reported the work of Bishopp et al. against Hypoderma larvae in the backs of cattle. Over 98 percent of the grubs can be killed with a general application to the backs of cattle of powdered derris root. A wash consisting of 1 pound of derris, 4 ounces of soap, and 1 gallon water has also given a percentage of kill above 96.

An ointment consisting of 1 part derris and 5 parts vaseline has also given almost 100 percent kill when the material was pressed into each hole.

Hollrung (50) in 1923 wrote that in Sumatra the following preparation had given good results against leaf lice on tobacco: 1-1/2 kg. fresh tuba root is mashed in 20 liters of water, which is diluted with an equal volume of water for use.

1924

The preparation of derris for use as an insecticide is described by an anonymous writer in the booklet "Plant Diseases and Pests" of the British Empire Exhibition (10), London, 1924.

> "For small caterpillars and suckling insects, where a simple wash is required, the derris spray can be made on the spot. Use the following proportions: - derris root 4-5 lbs., soap 2 lbs., water 50 (Imperial) gallons.
>
> "Cut the derris root into small pieces and pound to a pulp in a mortar with a little water. Inclose the pulp in a cloth and squeeze well in a larger quantity of water. To the extract obtained by this process add the soap, which has been dissolved in a little hot water. Then dilute to 50 gallons."

The same information was given by the Federated Malay States Department of Agriculture (30) in 1924.

Symes (89) in 1924 reported that two proprietary derris extracts gave highly satisfactory results against the black citrus aphis in Rhodesia.

Brittain (13) in 1924 described insectary feeding tests made in Fiske trays with potato beetle larvae. Arsenate of lead (paste) in the strength of 2 pounds to 40 imperial gallons was compared with various contact poisons, namely, nicotine sulphate, fish-oil soap, and derris powder, an attempt being made to use the last both as a contact insecticide and as a stomach poison. To test the contact action of derris (B) the insects were placed in a wire basket and dipped in the solution and then drained and fed on unsprayed leaves. To test the internal action of derris (A) the leaves were dipped in the solution and fed to the insects. The experiments lasted for a week, daily records being taken. The most notable results of the tests were those obtained in the case of derris, which in all strengths, ranging from 3 pounds to 100 imperial gallons to 1 ounce to 100 imperial gallons, and with both methods, destroyed 100 percent of the insects, including half-grown grubs, fully grown grubs, and adults. It seems certain that this material did not act as a stomach poison, because the beetles were found dead in the A trays, with no sign of any feeding.

The extreme toxicity of this material to potato beetles is shown by the fact that 1 week after this experiment was concluded a number of last-instar grubs were placed upon untreated leaves in a tray. The next morning the insects were found dead in the bottom of the tray without ever having

fed upon the leaves. On investigation it was found that this tray had been used in the previous week's test for one of the derris treatments (1 ounce to 100 imperial gallons). Evidently sufficient solution had been taken up by the cheesecloth bottom of the tray to cause the death of the insects. In comparing these results with field tests it would appear that the material is much more effective under insectary conditions.

Field tests to control aphids, Cavariella sp., on parsnips were made with derris (2-1/2 pounds of derris and 4 pounds of soap powder per 100 imperial gallons) and a commercial preparation of derris, Polvo (2-1/2 pounds per 100 imperial gallons). Derris root (Polvo) reduced the infestation very little even when soap was added. The same materials were used under insectary conditions with similar relative results. Derris was of no value against fall webworm larvae, Hyphantria cunea. Mature cabbage maggot larvae immersed for 5 seconds in a suspension of derris root (3 pounds to 100 imperial gallons) and then placed upon their food plant were unaffected, whereas a 1 - to - 1,000 mercuric chloride solution killed 10 percent. A similar test was made upon onion maggots, Hylemya antiqua. The results are as follows:

Age of maggot	$HgCl_2$, 1-1,000 solution percent mortality	Derris, 3 pounds in 100 imperial gallons of water percent mortalit
1 day	100	100
4 days	100	100
7 days	100	100
10 days	75	35
15 days	50	25
Ready to pupate	20	0

The following derris treatments gave perfect results in the control of head lice, Lipeurus heterographus Nitzsch, on young chicks: (a) Derris 1 part, plus 3 parts vaseline, 11 drams per 100 chicks; (b) derris powder 16 drams per 100 chicks; (c) derris 1 ounce, calcium caseinate 1 gram, and water 8 imperial gallons; the birds were rapidly immersed in the fluid and the feathers ruffled.

Corbett and Yusope (19) in 1924 stated that a spray of tuba root has a marked killing effect on Scotinophara coarctata F. at various stages, but since the quantity required would make the operation of spraying too costly, unless derris plants were grown by the cultivators, this method of combating the insect is not recommended.

Davidson (20) in 1924 reported the results of tests with derris powder and derris extract against the chicken mite. The composition of these materials was not known.

Four infested chicken houses inhabited by the common red mite of the chicken, Dermanyssus gallinae Degeer, were dusted with the finely ground powder of the roots of derris. Undiluted dust was efficient in one house and

temporarily so in another. In a third house a 75-percent dust was only moderately efficient; in a fourth test a 50-percent dust was inefficient. Flour was used as a diluent.

Davidson concluded that derris powder is a remedy of value, but it would appear that two or more applications are necessary and that it loses its efficiency if diluted more than 25 percent. It acts on larvae and adult mites by stupefying them, the insects dropping to the ground and dying after 2 or 3 days. The material is rather unpleasant to apply.

A commercial extract of derris, 16 percent, diluted to 1 to 1,000 and 1 to 500, with the addition of whale-oil soap, 4 pounds per 100 United States gallons, was inefficient.

De Ong and White (26) in 1924 reported the results of tests by H. E. Woodworth with species of derris from the Philippines as follows:

Scientific name	Parts used	Dilution of solution	Remarks
Derris elliptica	stem	20%	negative
	young shoot	20%	negative
	root	20%	positive
Derris philippinensis	leaves	20%	negative
	stem	1%	positive
	stem (boiled)	20%	negative
	roots	20%	positive
Derris sp.	leaves	20%	negative
	stem	20%	positive
	flowers	10%	negative
	leaves (boiled)	20%	negative

The insect used in these tests by Woodworth is not given.

De Ong and White reported the results of their own tests with derris as follows:

> The commercial extract of 16 percent concentration diluted 1 to 500 gave a 13-percent control on Aphis nerii Fons., and a 50 percent control on the green peach aphid, Myzus persicae Sulzer. Dilutions of 1 to 300 gave a maximum control of 68 percent on the latter species of aphid and 25 percent on the red spider, Tetranychus telarius L. Dilutions of the same concentrate at 1 to 500 added to mosquito-infested water killed 65 percent of the larvae but had no effect on the pupae. The powdered derris root (undiluted) sprinkled on the surface of the water killed 90 percent of the larvae in 2 to 4 hours. The same powder when dusted on aphids gave a 100 percent efficiency in 8 hours and a 98 percent control of the larvae of Euphydryas chalcedona D'bldy. and Hew. when dusted on the leaves upon which they were feeding. From these experiments it is judged that derris is both a stomach and a "respiratory" or tracheal poison. The reaction on the caterpillars must have resulted from ingestion of the powder, since fumigating tests with the material gave negative results.

Powdered derris root diluted to a 20-percent concentration with calcium carbonate, as well as the commercial derris dusts, gave perfect control on the chicken lice Menopon biseriatum Piaget and Goniocotes gigas Tasch. and the Gyropid lice Gyropus ovalis Nitzsch and Gliricola porcelli L. on the guinea pig.

Kopp (55) in 1924 reviewed the use of derris as an insecticide. Derris powder has given excellent results against plant lice,, Pucerons du Pommier (500 grams to 800 liters of water containing 1 kilogram of soap); Malacosoma (500 grams to from 32 to 800 liters of water); larvae of Hyphantria cunea; Anisota senatoria (500 grams to 100 liters containing 250 grams of soap); Datana ministra (500 grams to 200 liters); Autographa brassicae (500 grams to 100 liters containing 250 grams of soap); Lygidea mendax; Heterocordylus malinus; Leptinotarsa decemlineata (500 grams to from 64 to 500 liters of water).

MacDougall (60 and 61) in 1924 reported tests with a proprietary preparation of derris. Any scab and matted hair obscuring the exit hole of the larva in the skin was cleared away before the dressing was applied. One ounce of derris to 1 imperial quart of water killed 86 percent, and 1 ounce to 1 pint killed 94 percent of the warbles. No injurious effects attended any of the cattle dressed with derris for warble infestation and there was no discomfort to the hands of the dresser.

Howard (51) in 1924 reported that the active principle of Chara foetida was toxic to mosquito larvae and had been shown by MacGregor in England to be similar in its action to that of derris.

In 1924 the Minnesota Agricultural Experiment Station (71) announced that one of its projects in economic entomology was the study of derris for the control of external parasites of domesticated animals, under the direction of Paul M. Gilmer and O. C. McBride, but no report on this project appears to have been made.

McIndoo and Sievers (65) in 1924 published the results of tests with 232 preparations from 54 species of plants against 28 species of insects.

Following are the summarized results, obtained by using a commercial powder, consisting of a mixture of Derris elliptica and D. uliginosa. The powder, used as a dust, was efficient against three species of aphids (Aphis sp. A and B and Macrosiphoinella sanborni), and silkworms, but killed only about half of the Macrosiphum sp. A tested within 24 hours; used as a decoction (No. 110a, not filtered) and also as a hot-water extract (No. 110b, filtered), it was efficient against Aphis sp. A and B; and used as a fumigant, it was efficient against Myzus persicae Sulz., Macrosiphum sp. C, silkworms, and the lady-beetle tested, but inefficient against webworms and small tent caterpillars.

The alcoholic and benzene extracts of derris, when sufficiently strong and used with soap or kerosene emulsion, were found efficient against many species of aphids. The alcoholic extract, used with soap, was efficient against half-grown sawfly larvae, but inefficient against small webworms (first instar) and the larvae and adults of potato beetles.

At Tallulah, La., a commercial preparation of powdered derris was used on three dogs which were infested with fleas, Ctenocephalides canis Curt. It was found efficient against the fleas.

Fulmek (34) in 1924, in discussing insecticides for use against tobacco pests in Sumatra, listed akar tuba as a contact insecticide. The addition of 0.3 to 0.5 percent of soap to solutions of derris is advised.

Fulmek (35) in 1924 recommended akar tuba for leaf lice at the rate of 1 kilogram in 100 liters of water to which 0.5 kilogram of soap is added.

1925

Gater and Yusope (40) in 1925 stated that the usual aqueous derris extract as made in British Malaya would form an effective spray against young caterpillars of Laelia suffosa Wlk. damaging padi.

Gater (39) in 1925 reported dipping tests with mature larvae of Parasa herbifera Walk., larvae of Tirathaba sp., and nymphs of Dysdercus cingulatus F. The latter is particularly susceptible to derris. Gater concluded that the insecticidal constituents of derris are almost if not completely destroyed by the digestive fluids of a bostrichid.

Walton (106) in 1925 reported that preliminary trials of derris ointment prepared according to the formula of Wells, Bishopp, and Laake (109) had been made for the control of warble flies in North Wales. The results obtained with 91 cattle were most promising.

Bourcart (9) in his book Insecticides, Fungicides, and Weed Killers, English translation of 1925, stated that a spray containing 1 pound of derris, 10 imperial gallons of water, and 5 ounces of soft soap is effective against aphids infesting tobacco in Sumatra. The derris roots, which may be dry or fresh, are cut into small pieces, placed in a little water, and then pounded into a paste, which is diluted with a gallon of water and left standing overnight in a wooden vat. An iron container must not be used. The dregs are then pressed, and all the fluid is strained through a cotton cloth. The resultant concentrate is a milk-white solution, which keeps for a few days only. It is diluted with 9 parts of water for spraying. About 16 imperial gallons of solution are needed for 1,000 tobacco plants that have been 25 to 30 days in the field. Twice this quantity is needed for full-grown plants. If derris roots are to be stored, they must be kept dry.

Fulmek (36) in 1925 gave directions for spraying against leaf lice with derris. The formula is 1 kilogram of akar tuba (derris), 100 liters of water, and 300 grams of soap.

Harukawa (49) in 1925 reported tests made in Japan with "tuba-fluid", a whitish solution made from derris roots supplied by an insecticide dealer. The method of preparation was unknown to the author. The author tested this solution on various insects and found that it was particularly effective against the larvae of the rush sawfly. The tuba fluid, diluted with 1,000 times its volume of water, killed 100 percent of the larvae. Parallel experiments made with the tuba fluid diluted with soap water showed that there is practically no different in effectiveness between the solution diluted with water alone and that diluted with soap water.

The Michigan Agricultural Experiment Station (69) in 1925 reported that derris sprays had given encouraging but not conclusive results against the black cherry aphid and various apple aphids.

Otanes (73) in 1925 wrote that in certain parts of the Visayan Islands, as in Cebu, it is said that farmers sometimes use the roots of Derris (species unknown) for combating the rice borer, by scattering chips of the roots and stem. The juice mixes in solution with the water, and when the caterpillars come in contact with the water, as when they transfer from stalk to stalk or after hatching, they get poisoned and soon die. Just how effective this remedy is has not been scientifically determined. If this poison will really kill the rice borer it would probably be equally effective against the rice case-worm, Nymphula depunctalis.

K. M. Smith (85) in 1925 reported on the control of certain maggots attacking the roots of vegetables. Tests were made with various insecticides for the control of the onion fly, Hylemya antiqua Meig., the carrot fly, Psila rosae., the cabbage root fly, Chortophila brassicae Bouche, and the turnip gall weevil, Ceuthorrhynchus pleurostigma Marsh. A mixture of 1 ounce of derris with 2 ounces of soot per square yard did not give results promising enough to justify further trials with it.

Howard (101) in 1925 reported that further investigations had been made in the Bureau of Entomology of insecticides derived from derris.

McBride (63) in 1925 was assigned one of the projects in entomology and economic zoology of the Minnesota Agricultural Experiment Station entitled "A study of derris and related insecticides for the control of external parasites of domesticated animals", but no report of work under this project was published.

1926

An anonymous writer (1) in the Gardeners' Chronicle in 1926 stated that insecticides derived from Derris elliptica may prove ultimately to be the means of freeing us from the use of arsenical sprays. Preparations of this kind are already on the market and appear to give excellent results.

Reutter (79) in 1926 stated that an extract of derris plus tobacco extract is used as a powerful insecticide.

Vogt and Appel (105) in 1926, in their book "Die Chemischen Pflanzenschutzmittel," included Derris elliptica in a list of stomach poisons.

Bishopp (5) in 1926 reported that fresh derris powder is exceedingly effective in destroying fleas on animals. All fleas on a dog will be destroyed by one application of 1 gram or about three-fourths of a level teaspoonful of the powder. It is suggested that the material be mixed at the time it is used with 2 parts of flour or cornstarch and dusted into the hair of the animal, especially along the back and neck, with a shaker. The skin of cats is much more easily injured with chemicals than that of dogs; hence any preparation used should be weaker when used on cats than on dogs.

An anonymous writer (2) in Korte Berichten voor Landbouw Nijverheid en Handel in 1926 described the preparation of an insecticide spray from derris root. Only fresh root is used. A bundle weighing 1-1/2 catty (1 catty=1-1/3 pounds) is sufficient for a 1/4-acre garden plot. It is chopped up, extracted in 2 gallons of boiling water, and diluted 1 to 4. It is preeminent among chemical insecticides in that it does not harm even the most tender foliage. When used on dogs, it kills the fleas without irritating the skin, but should not be used in the presence of scabies. An extract of it is also used against the caterpillar and other harmful insects.

Bishopp, Laake, Brundrett, and Wells (6) in 1926 reported the results of tests of insecticides against cattle grubs or ox warbles.

A proprietary derris extract, 1 part, plus 10 parts of water (containing 4 ounces of soap per gallon), killed 100 percent of cattle grubs (larvae of Hypoderma lineatum) when injected with an oil can directly into the grub holes in the backs of cattle. Derris powder, 8 ounces, plus soap, 4 ounces, per gallon of water, applied twice as a wash on the back also killed 100 percent of the grubs. Tests with dry derris powder, derris powder with paraffin oil, derris powder with petrolatum, derris powder with soap and water, and derris powder with water only are recorded.

The percentage mortality of Hypoderma bovis is not so high as that of H. lineatum.

The authors concluded:

> "Tests of the application of washes, powders, and ointments to the backs of the cattle and also the injection of substances into the cysts containing the larvae show that each of these methods of treatment is effective if certain materials are used. Among the most effective should be mentioned: Derris used as a wash, as an ointment, or as a powder; iodoform used as an ointment; pyrethrum applied as an ointment; benzol and carbon tetrachloride injected into the grub cysts; fine tobacco applied in powder form and nicotine dust applied dry."

Carlos (17) in 1926 reported that derris as a contact or external poison, with or without the use of soap as a spreading agent, had been found effective against aphids in as low a dilution as 1 pound of root to 400 imperial gallons of water, which represents a proportion of 0.025 percent. As a stomach or internal poison, stronger solutions are required, the lowest being 1 pound to 125 imperial gallons of water, or 0.08 percent. Caterpillars, aphids, psylla, and red spiders are some of the chief insect pests which can be easily exterminated by the application of insecticides containing derris or its products. One interesting property of derris as a killing agent is that the effect lasts for a considerable time. Leaves when sprayed with a solution containing derris preparations will remain poisonous to insects for many days.

Castillo (18) in 1926 reported the results of studies on the insecticidal properties of three species of derris growing in the Philippines, namely, D. polyantha Perk., D. philippinensis Merr., and D. elliptica (Roxb.) Benth. The roots were cut into thin transverse slices and dried in an oven at 40° C. until the weight remained fairly constant. The dried material was then comminuted in a mortar and the powdering finally completed in a meat grinder. The fine powder was separated from the fibers by sifting through fine-meshed cloth.

In the comparative studies of the effect of various concentrations, Derris philippinensis was used on account of its being relatively more abundant, hence more easily procurable, than the others. Insects of two types of habitat were used, namely, an aquatic insect, the mosquito larvae, and an aerial insect, Aphis medicaginis Koch. On mosquito larvae the most effective concentrations of D. philippinensis in bringing about the highest percentage of deaths in the quickest time was 3:1,000. Solutions which were either more dilute or more concentrated than 3:1,000 were found less effective. Concentrations of 1:1,000 killed 19 percent of the larvae in 5 days; lower concentrations showed no effect at all. A concentration of 3:1,000 or higher retained its toxicity against mosquito larvae for 13 to 16 days. Concentrations higher than 3:1,000 presumably became effective later, as a result of deterioration and consequent lowering of the percentage of toxic principles present. The concentration of D. philippinensis which brought about the largest number of deaths of aphids was much higher than that required for mosquito larvae, namely 4:1,000. The lowest concentration of D. philippinensis used, 0.5:1,000, caused a noticeable percentage of mortality among aphids, as compared with the control.

Against both mosquito larvae and aphids, Derris polyantha was more effective than either of the other two species. In both cases, in aqueous solutions, it showed its superiority (1) in bringing about the highest percentage of deaths, (2) in the short time it required to kill, and (3) in the retention of its virulence. D. polyantha retained its virulence in water and was toxic to mosquito larvae for a period ranging from 13 to 16 days. D. elliptica and D. philippinensis were toxic for only 1 to 2 days.

Durham (27) in 1926 gave an interesting account of his early work with derris, which he regarded as essentially a stomach poison.

> "Starting in the Malay States in 1902, where some field trials showed it a potent agent for the destruction of mosquito larvae, work was continued on my return up to 1907; it was not possible to publish the large amount of observations in those days, and naturally the loss of time made it difficult to use old notes. A fairly large scale trial was made in the late Dr. W. H. Maskell's garden at Shelford on 13th June, 1904, where the Gooseberries were alive with saw-fly larvae; the larvae were promptly killed, and the cooked fruit gave rise to no unpleasant symptoms in the consumers.
>
> "In those now far off days a number of larvae of the Small Eggar of good size were put on a spray of leaves which had been dipped in a suspension of the derris root; they were all dead next day, when a further supply of larvae was put on, the leaves being now dry; the controls had had the leaves wetted with water in case mere wetting might have an effect. This renewal of application of larvae continued till the leaves became too withered in about ten days; none of the controls died, and all of the derris-fed larvae were killed. Open air trials showed that the poison still remained active for at least a fortnight. Here the effect is clearly as a stomach poison.
>
> "On the other hand, a very extensive series of trials was made upon the black bean aphis and the woolly aphis; in the latter case the trials were carried on throughout the summer, both with spraying and with careful use of a camel-hair brush so as to get thorough wetting of the patches, which had a milky appearance when treated. The woolly aphis is, of course, difficult to wet, but in neither case was there any appreciably diminution. I cannot but think that the irregular results which have been obtained with contact trials have been due to the insects sucking some droplets of the fluid when dislodged ere they plunged in their beaks or in the case of the somewhat crude method of bathing caterpillars some of the poison may have been licked up. The slow death of mosquito pupae (perhaps two or three days after the larvae) suggests that absorption of the extremely insoluble agent takes place, mere contact not sufficing. Whether or no in some cases there may be a contact effect, the main utility of the drug must be as a stomach poison.

"The most susceptible creature that I know is the 'water flea' (Daphnia and Moina), which dies rapidly in the most amazing and incredibly high dilution of the poison; tadpoles and mosquito larvae were found to be very good experimental subjects for recognizing the potency of different preparations. The first large-scale trial was made on a fruit plantation of Mr. Clough, at Burley, Hants, on the 23d May, 1904. In all these trials the roots were ground up with successive lots of water and no other ingredient added. I still have some of the original roots, now some twenty years old, and though they have not been regularly tested for strength, they still retain some active power, and a solution is ladled on to small seedlings when 'cut worms' are about.

"A curious feature in derris is the localisation of the poison to the roots; trials of stem extract showed very slight activity and the leaves nil, indeed, it may be noted that they are attacked by some caterpillar occasionally (sp. not known to me.)"

Kelsall, Spittall, Gorham, and Walker (54) in 1926 published the results of tests of derris against several insects.

They are disposed to regard derris as a contact poison only. Tests upon the Colorado potato beetle, Leptinotarsa decemlineata Say, with derris in 4-4-40 bordeaux, derris and hydrated lime, and derris alone lead to the following conclusions: Derris is effective in both spray and dust form; derris kills more rapidly than arsenicals; derris is less effective mixed with hydrated lime, and still less effective mixed with bordeaux mixture. To get the same eventual kill, 1 pound of derris is apparently about equivalent to from 1-1/2 to 3 pounds of calcium arsenate.

A 5 or 6 year old sample of derris was ineffective against the forest tent caterpillar, Malacosoma disstria Hbn., when dusted or sprayed upon chokecherry foliage fed upon by the caterpillars.

Against the orchard tent caterpillar, Malacosoma americana F. It was shown that (1) the derris applied to the caterpillars along with the foliage gave very much higher control than where applied to the foliage alone; (2) 1 pound of derris per 100 gallons of water gave an equal eventual control, though much more rapidly, than 2 pounds of lead arsenate; (3) when applied direct to the foliage but not to the caterpillars derris was not quite equal pound for pound to lead arsenate; (4) derris was very much more effective than nicotine in practical strengths.

Derris at 1/3 pound per 100 imperial gallons of water killed 100 percent of imported currant worms, Nematus (Pteronidea) ribesii Scop. A dust of 98.75 parts hydrated lime and 1.25 parts derris gave 100 percent control in a heavily infested currant plantation.

Derris at the rate of 5 pounds per 100 gallons was sprayed on house flies. The spray was shot at them both while they were resting

and while they were on the wing. Such flies became restless almost immediately and commenced cleaning themselves vigorously. Most flies so treated were dead within 24 hours, and as far as could be ascertained all were dead within 48 hours.

Derris was also dusted on house flies but in this case the action was much slower and after one day none were dead, and it was thought the material was not effective. These flies were not kept under observation afterwards but later work with derris led Kelsall and associates to think that had they been kept under observation longer, a subsequent mortality might have been noted.

Derris spray was also observed to kill several other flies of undetermined species, and was also observed to kill certain noctuid moths.

Against the carrot rust fly, Psila rosae F. derris, in either dust or liquid form, gave a considerable measure of control, the material being applied to the soil surface about the time egg laying was in progress, the control being apparently also accompanied by a plant stimulation.

A trunk of woolen goods swarming with adult clothes moths was given a liberal application of a 50-50 derris-hydrated lime mixture. Four days later all moths were dead. The trunk was examined a month later and no living larvae and no moths were found.

A number of bedbugs, Cimex lectularius L., were confined in a vial with derris dust. They were active for 2 hours, but were all dead after 3 1/2 hours.

Derris spray, 2 pounds to 100 imperial gallons of water, was ineffective against budworms (mostly Spilonota ocellana D. and S.). The fall webworm, Hyphantria cunea Drury, is quite strongly resistant to derris dust and derris spray (10 lbs. to 100 gals.). Against the green apple aphid, Aphis pomi DeG., derris, 5 pounds in 100 gallons without soap, gave practically complete control, being a little superior to 1 pound of nicotine sulphate (40 percent). With the addition of a little soap to the solution, derris as low as 2-1/2 pounds to 100 gallons of water gave 100 percent mortality, and is superior to 1 pound of nicotine sulphate (40 percent).

A dust containing as high as 20 percent of derris plus 80 percent of hydrated lime proved ineffective against the green apple aphid when applied to dry foliage. Derris dust requires moisture to make its toxic properties effective against this aphis.

In the insectary, tests were made against the potato aphid, Macrosiphum solanifolii Ashm. The presence of moisture had a marked effect in increasing the toxicity of derris, for derris as low as 2.5 percent in dust gave complete control. Derris in spray form required 5 pounds per 100 gallons of water to produce 100 percent mortality, while nicotine sulphate (40 percent), 1/2 pint to 100 gallons, gave the same control. In all cases it was found that derris was much slower in action than the nicotine.

Aphis rumicis L. in an insectary experiment was killed completely but slowly by derris, 5 pounds to 100 gallons. Derris spray 2-1/2 pounds to 100 gallons gave a mortality of over 90 percent of imported cabbage worms Pieris rapae L., on cabbage. Dusts of hydrated lime and derris were not so effective. The authors concluded that the moisture usually retained by cabbage foliage undoubtedly assisted in bringing out the toxic properties of derris.

Undiluted derris dust, applied with a hand duster, gave 100 percent control of larch sawfly larvae. Derris dust had apparently no effect on Chermes. The three-lined potato beetle was controlled by a dust application of 50-50 derris and hydrated lime, but this mixture had apparently no effect on the squash bug. A red aphid on goldenrod and the currant aphid were not controlled on being dusted by the same mixture, but reasoning from other experiments it is possible that they might have been if in the presence of moisture.

Derris, both dust and spray, gave a measure of control against the larch case bearer.

Derris, both dust and spray, was ineffective against the chain-dotted geometer, but arsenicals were practically ineffective against them also.

Derris, 1-1/2 pounds per 100 gallons of water, with the addition of soap, was used against aphids on a cut-leaf birch. Geometrid larvae, lady-bird beetle larvae, and syrphid fly larvae were killed and dropped in a few hours, but the aphids did not appear to be affected during the first 12 hours. Two days later the tree was found to be completely free of aphids.

Derris was not effective in a bait fed to cutworms, either in the insectary or in the field.

It was noted in some cases that where dusts containing derris had been supplied to plants, and later rains had washed the dust into the soil, the earthworms came to the surface of the soil and died.

Derris, applied at approximately the rate of 1 pound per 100 gallons, added to a large tank of water very heavily infested with mosquito larvae, completely killed all the larvae in 3 or 4 days.

It was also noted that if slugs traveled over a surface on which derris had been lightly sprinkled, the slugs immediately became distressed and died in a few hours.

Derris, used undiluted and also at the rate of 1 part of derris to 3 parts of dry cement powder, was found very effective against lice on cattle and horses.

McBride (64) in 1926 reported tests with insecticides against a leaf-hopper, Eupteryx flavoscuta var. nigra. Osb., attacking the leather-leaf fern, Polystichum capense J. Sm., in Florida.

Tests were made with nicotine-lime dust, nicotine sulphate, calcium cyanide, and derris. Five percent extract of derris, 1 to 600 and 1 to 600, plus soap, 2 pounds of 50 gallons, gave satisfactory control, but was slow in its effective work. The fernery was free from leafhoppers for 13 days after the spraying with derris. The reinfestation occurred from eggs deposited before the application of the spray. A second application of nicotine sulphate gave 75 to 80 percent control, whereas 5 percent extract of derris gave 98 to 99 percent. A small amount of injury was observed on all the sprayed plots. It was thought to be a mechanical injury and not considered of any commercial importance.

Miles (70) in 1925 reported good control of the pea moth Laspeyresia nigricana Steph. with the use of a derris spray, 20 pounds of powdered derris to 100 imperial gallons of water. This spray produced the lowest percentage of damage (16 percent) in the threshed peas. The percentages of damaged peas harvested from plots sprayed with derris or nicotine show little difference from those observed when the green peas were examined; it would seem, therefore, that these sprays have a permanent effect.

Nozu and Soneyama (72) in 1926 recommended spraying with derris mixtures for the control of the chrysomelid Phaedon incertum Baly.

The Deli Proefstation at Medan (22) in 1926 reported that akar-toeba extract gave excellent control of aphids. Some difficulty was experienced in obtaining a uniform extract, so this was prepared with the machinery of the Delische Kleiindustrie. Formalin was added, to a concentration of 2.5 percent, as a preservative.

Tattersfield, Gimingham, and Morris (82) in 1926 reported tests of Derris elliptica and rotenone against Aphis rumicis L. Tubatoxin (rotenone) at a concentration of 2.5 to 0.075 gram per liter killed all aphids; 0.01 gram per liter caused 20 percent to be moribund. Tubatoxin proved to be several times more toxic than nicotine.

1927

Quaintance (77), chairman of the committee of the American Association of Economic Entomologists to formulate plans for investigations of the codling moth from biologic and control standpoints, reported at the 1927 annual meeting of this association that, according to Van Leeuwen, derris in laboratory and field tests in New Jersey had shown promise for the control of the codling moth.

An anonymous writer (3) in Weinbau and Kellerwirtschaft in 1927 reported the results of experiments with Derris elliptica in Korea. A thorough application of a commercial product [probably Neoten -- R. C. R.] by means of a sprayer gave good results in the control of the mites responsible for the curly-leaf disease. Repetition was necessary because of uneven budding of the vines. The rapidity of the action varies with different insects. A swarm of almost grown Tinea moths on an oak were killed in 1/2 to 1 hour. Black lice on chestnut trees fell off in a few minutes. Rosebush aphids were also quickly killed. Cabbage worms lived 1/4 to 1/2 hour. Cabbage butterflies flew away. A large hornet in flight was stunned,

and later died. Against the above insects the product was used at the rate of 100 grams in 300 liters of water. Against caterpillars, 100 grams to 45 liters can be used, if 2 pounds of any cheap soap is admixed. Spraying in summer suppresses later generations of these mites, which are then rather large, as well as the irksome vine cicada.

Mention is made of derris in the report of the Committee on Policy of the American Association of Economic Entomologists at its 1927 meeting. Gibson (43), chairman, stated that various new spray mixtures containing extracts of pyrethrum and derris have been tested as substitutes for nicotine and the results have been favorable in most cases. Under Toxicity Investigations, it is mentioned that derris is one of the contact insecticides which have been investigated.

Bange (4) in 1927 reported the use of the decoction of the roots of Derris elliptica against caterpillars of the diamond-back moth, Plutella maculipennis Curtis. Because it is not entirely effective, lead arsenate is mixed with it.

Blieck and Baudet (8) in 1927 reviewed the work of Bishopp et al. (6) on derris against ox warbles.

Caesar (15) in 1927 included derris with arsenicals and sodium fluosilicate under the classification "Stomach Poisons." It is described as "a light, brown powder made from the roots of certain shrubs grown in the Far East, especially in the Malay peninsula. It is supposed to be both a contact and stomach poison and when used as a dust is usually diluted with air-slaked lime or hydrated lime or gypsum in the proportions of about 1 part of bulk to 20 or even 40 parts of the diluent. As a spray it is quite harmless to foliage even with water alone. It is a good insecticide against a considerable number of insects but not against all. Unfortunately it is even more difficult to secure than sodium fluosilicate, though it will likely be put on the market in the comparatively near future."

The Deli Proefstation (23) in 1927 reported that derris extract was satisfactory for the control of aphids on tobacco and caused no burning of the leaves. These derris extracts (suspensions of the milky sap in water) supplied by the Deli Proefstation to tobacco growers retain their toxicity for at least 1 year when kept in well-closed barrels. Decomposition occurs in open vessels and in those not hermetically closed. The suspension becomes gray or nearly black, develops the odor of hydrogen sulphide, and loses effectiveness. Contact with iron is stated to be undesirable.

Dennis (24 and 25), in United States Patent 1,621,240, issued March 15, 1927, and in Reissue 18,667, issued November 22, 1932, stated that an alcoholic extract of cube is eight times as effective as similar derris extract when sprayed on the cotton aphid.

Fulmek (27) in 1927 reported the use of a 1-percent water extract of the roots of Derris elliptica for the control of plant lice on tobacco.

Gibson (41) in 1927 reported that powdered derris root has lethal properties when used against culicine mosquito larvae. When dusted on the surface of water containing larvae of Aedes vexans Mgn. this material, either alone or in combination with an inert filler, was found to destroy the larvae in a few hours even when used at the rate of only 2 or 3 pounds of derris to the acre.

Howard (102) in 1927 reported that tests with insecticides against cattle grubs made at Burkes Garden in Virginia indicated that powdered derris root will give a high percentage of kill if applied and brushed in at intervals of about 20 days.

Leefmans (56) in 1927 reported that on the Sumatra East Coast cabbage growers are mixing lead arsenate with the usual derris solution.

"We can report that a derris suspension in water against cabbage caterpillars gave unfavorable results. On the other hand, we have obtained excellent results if finely pulverized derris was extracted with alcohol. The practical conclusion is that addition of a water suspension of derris or derris roots to a solution of lead arsenate is wholly useless since the latter, with the addition of soap, is satisfactory."

Van der Meer Mohr (87) in 1927 reported that Myzus persicae Sulz. is a serious pest of tobacco in Deli, Sumatra. The seed beds are infested from the adjacent forests, and the young plants in the field are either infested in the same way or by the introduction of infested seedlings from the beds. If the beds are very badly infested, the seedlings should be destroyed or dipped in derris solution, experiments having shown that this does not harm them. In the plantations a daily watch should be kept for the first traces of infestation. Spraying with a solution of derris is advised. The application must be repeated after 4 to 5 days.

Parman et al. (74) in 1927 reported results of chemotropic tests with the screw-worm fly. A commercial derris powder repelled 95 percent of the screw-worm flies visiting a bait of beef liver. This is about the same figure as that obtained with pyrethrum powder.

Roark et al. (83) in 1927 reported that derris powder when undiluted repelled 95 percent of the screw-worm flies visiting fresh beef liver, and when diluted with 9 parts of kaolin it repelled 38 percent.

Sonan (87) in 1927 reported that spraying with derris and soap proved very effective against the following pests infesting tea plants in Formosa: Lymantriids, Euproctis pseudoconspersa Strand, E. sericea Wileman, Porthesia taiwana Shir., P. scintillans Walk., Pseudodura dasychiroides Strand, Clene mendosa Hon., Notolophus posticus Walk., Stilpnotia cygana Moore, and Arctornis alba Bremer.

In his annual report as entomologist of the Federated Malay States Department of Agriculture (31) for 1927, Corbett mentioned investigation on the insecticidal value of derris (in collaboration with the agricultural chemist) as one of the main researches of the division of entomology.

Tanaka (91) in 1927 recommended a derris soap spray for the control of the older larvae of the Notodontid Drymonia manleyi Leech.

Twinn (96) in 1927 reported on mosquito control at Ottawa, Ontario, Canada. The derris was dusted on the water surface at the rate of approximately 3 pounds per acre. The larvae died within periods ranging from three-quarters of an hour to more than 7 hours. In all cases the larvae, before death, became very feeble, lying motionless and parallel with the surface of the water, moving with difficulty when rudely disturbed. The pupae died more slowly than the larvae, more than 24 hours sometimes elapsing before death occurred.

Tests were also made upon a shallow pool about 200 square feet, with a grass-grown bottom. This pool contained large numbers of larvae of Aedes vexans Meig. A mixture of derris and French chalk in the proportion of 1 part of the former to 4 of the latter was dusted just before sundown on the surface of the water by means of a small hand dust gun, at the rate of 1-1/2 pounds of derris to the acre. The material settled well, forming a very satisfactory film of dust over the entire surface. When examined 16 hours later, a considerable proportion of the larvae were dead and many of the living revealed the effect of the derris in their sluggish movements. The pool was not examined again until 60 hours after treatment. On this occasion all the larvae were dead, many floating on the surface of the water.

Walton (107) in 1927 reported further notes on the control of warble flies in North Wales. The killing properties of derris appear to be excellent. The ointment (1 part of derris powder plus 2 parts of soft paraffin) is odorless, and the cost is low (about 2-1/2 pence per ounce) in experimental amounts. On the other hand, the ointment was found to be much more difficult to apply, and olive oil was utilized, the ointment then consisting of 1 part of powdered derris, 1 part of soft paraffin, and 1 part of olive oil. This improved the texture and rendered application easier.

Watanabe (108) in 1927 recommended spraying the young growth of cruciferous vegetables with derris to combat Hellula undalis F. (Pyralididae) in Japan.

Trappman (94) in 1927 gave a short account of derris. A formula for a derris spray is 1 kilogram of finely powdered derris powder, one-half kilogram of soap, and 100 liters of water. Derris powder may be added to a lead arsenate (1 percent) and soap (0.3 percent) spray for use on young tobacco plants.

1928

Thompson (93) in 1928 tried derris in poison bait against leather jackets in South Wales and found that, although it did not give as good results as the paris green bait, it is obviously of definite insecticidal

value when used in this way. On the derris-treated plot numerous earthworms were found lying dead on the surface and also some slugs. Derris powder clearly does not render the bait distasteful to the pests named, as appeared to be the case with sodium fluosilicate. The derris bait was composed of 10 pounds of bran and half a pound of derris powder distributed over half an acre of oats. Thompson concluded that derris powder gives moderately good results.

De Long (21) in 1928 reported that a commercial derris product diluted 1 to 250 proved unsatisfactory against the potato leafhopper, Empoasoa fabae Harris.

Garman (38) in 1928 reported experiments made in Connecticut with insecticides offered as substitutes for nicotine sulphate. One of the commercial preparations of derris was tried in 1927 against the mealy plum aphid and showed good killing power, although it failed to accomplish a thorough clean-up on account of poor spread. It is quite evident that soap or casein lime is needed in combination. The product investigated does not mix well with winter-strength lime-sulphur solution.

Both derris and pyrethrum have considerable value as aphicides, but their success for orchard use will depend on their ability to combine with other insecticides and fungicides. The present cost does not seem to be any lower per 100 gallons of spray mixture than nicotine sulphate, and no reliable information is available regarding their keeping qualities. The only advantage that can be seen from using the above-mentioned aphicides in an orchard will lie in increased safety of the operator.

Tests with derris and pyrethrum against the mealy plum aphid gave the following results:

Substances (commercial preparations)	Dilution	Percent of kill
A. Derris preparation	1 oz. to 6 gal.	88.3
B. Derris preparation	2 oz. to 6 gal.	97.6
C. Pyrethrum soap	2 lb. to 3-3/4 gal.	94.4
D. Nicotine sulphate	1 oz. to 6 gal.	92.2
E. Check, no treatment		0.

Gibson (43) in 1928 reported that under laboratory conditions powdered derris root dusted on the surface of water in shallow trays at the rate of 15 pounds to the acre of water surface destroyed Aëdes larvae in a period ranging from 3 to 22 hours, and pupae in from 2 to 5 days. In an experiment conducted by Mr. Twinn at Hawkesbury, Ontario, it was noted that when the powdered derris root was dusted on the surface of polluted pools of water heavily infested with Culex pipiens larvae, at the rate of 30 pounds to the acre of water surface, 97 percent of the larvae were destroyed in 48 hours and 100 percent in 72 hours.

Ginsburg (46) in 1928 reported that a suspension of derris (1-400) killed 100 percent of the honey bees after 24 hours, and suspension of cube root (1-200) killed 100 percent of the bees after 48 hours. These suspensions were mixed with honey and fed to the bees.

Gorham (47) in 1928 reported on the European rose sawfly in New Brunswick, Canada. It was found that, like other sawfly larvae, these were very susceptible to the toxic action of derris dust and that they dropped in a helpless condition within 2 hours after application. No objectionable stains were left on the foliage or blooms.

Leynen (58) in 1928 reported that the "Commission Hollandaise du Varron" recommends derris powder for Hypoderma larvae, as recommended by Bishopp et al. (6) in United States Department of Agriculture Bulletin 1369.

Parman et al. (75) in 1928 reported that derris powder, 0.5 gram, plus kaolin, 4.5 grams, when spread upon 4-ounce cubes of beef liver in a mason jar repelled 38 percent of the screw-worm flies and 81 percent of the Lucilia flies that approached the meat.

Quaintance (78), at the 1928 annual meeting of the American Association of Economic Entomologists, reported that derris had been tested for the control of the codling moth in Arkansas, Colorado, Illinois, Indiana, Kansas, New Jersey, and Washington. In Illinois good results were obtained with commercial derris extract combined with white oil, 1-1/4 percent. An alcoholic extract of derris used against second-brood worms appeared to be of little value.

Tamanuki (90) in 1928 recommended derris and soap spray for the control of Galerucella rubi Tamanuki on the young leaves of strawberry plants in southern Sakhalin.

Schwartz and Shook (84) in 1928 recommended that, for combating fleas on rabbits, the animals be dusted with pyrethrum powder, or powdered naphthalene, or powdered derris root.

Ripley and Hepburn (80) in 1928 reported on top-dressing maize against the stalk borer. Powdered derris root when applied in water at 1 to 90 is much more effective than when used as a powder at 1 to 12. The killing power of a dry powder under the conditions of top-dressing is far below that of the same powder diluted to the same extent but applied as a suspension in water. This is perhaps explained by the fact that when suddenly wetted by a liquid the borers swallow some of it (as is easily shown by using a colored liquid and dissecting the digestive system after dipping), whereas they do not appear to swallow a dry powder very readily. Thus the liquid can act as a stomach poison more effectively than the powder.

> "It was hoped that by mixing two insecticides that were known to act differently upon the borer, such as derris and a fluorine compound, or nicotine and an arsenical, the result might be a killing power greater than that of either of the two ingredients used separately, but at the same concentration as the mixture. Various experiments on this point were performed, but no advantage of mixing was shown, the killing power of the mixture always proving to be intermediate between those of the two ingredients."

Van Leeuwen (104), at the 1928 codling moth conference of the Bureau of Entomology, reported tests of various insecticides for the control of the codling moth in the Riverton, N. J., district.

"We found that three early applications of lead arsenate against the first brood followed by three applications of pyrethrum, nicotine, or derris against the second brood gave good results. Check trees showed 83 percent of all apples free from worms, whereas the lead-arsenate plat showed 97 percent, nicotine 95 percent, pyrethrum 93 percent, and derris 95 percent free from worms." In laboratory tests with newly hatched codling moth larvae, derris, pyrethrum, and nicotine gave very encouraging results. Further laboratory tests will be made.

The Bureau of Entomology (103), in its 1928 annual report, mentioned that extracts of derris at 1 to 800 had been tested as contact sprays and as ovicides against the codling moth.

Metcalf and Flint (68) in 1928 summarized current information on derris. Derris is recommended for aphids, for lice and fleas on domestic animals, and as a wash for killing ox warbles in the backs of cattle. Derris sprays are effective in killing the young nymphs of apple leafhoppers, and against greenhouse thrips. For checking sheep lice in winter when dipping cannot be done safely, dusting pyrethrum or derris into the wool is recommended. Dry powdered derris or pyrethrum sifted into the fur of pets controls fleas.

Table 1.--Classified list of insects against which derris has been tested

Insect and Stage	Preparation	Effectiveness	Reference
Orthoptera			
Blattidae			
Blattella germanica L. (German cockroach)	Powder + tobacco dust (1+4) as a dust	Effective	Gilmer (44) in 1923
Ditto	Powder + tobacco dust (1+4) + flour and sugar as a bait	Effective	Ditto
Ditto	Powder as a dust	57.5% kill in 1 week	McIndoo, Sievers, and Abbott (66) in 1919
Periplaneta americana L. (American cockroach)	Powder + tobacco dust (1+4) as a dust	Effective	Gilmer (44) in 1923
Ditto	Powder + tobacco dust (1+4) + flour + sugar as a poison bait	Effective	Ditto
Gryllidae			
Gryllotalpa sp. (mole cricket)	Extract	Uncertain	Federated Malay States Dept. Agr. (28) in 1920
Mallophaga			
Mallophaga on chickens	Powder as a dust	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Powder as a dust	Effective	Wells, Bishopp, and Laake (109) in 1922
Ditto	Powder in water (1:531)	Effective	Ditto

Insect and Stage	Preparation	Effectiveness	Reference
Mallophaga (cont.)			
Gyropidae			
Gliricola porcelli L.	Powder + inert (1+4) as a dust	Effective	Calif. Agr. Expt. Sta. (16) in 1923
Ditto	Powder + $CaCO_3$ (1+4) as a dust	Effective	De Ong and White (26) in 1924
Gyropus ovalis Nitzsch	Powder + inert (1+4) as a dust	Effective	Calif. Agr. Expt. Sta. (16) in 1923
Ditto	Powder + $CaCO_3$ (1+4) as a dust	Effective	De Ong and White (26) in 1924
Menoponidae			
Menopon biseriatum Piaget	Powder + inert (1+4) as a dust	Effective	Calif. Agr. Expt. (16) in 1923
Ditto	Powder + tobacco dust (1+4) as a dust	Effective	Gilmer (44) in 1923
Ditto	Powder + $CaCO_3$ (1+4) as a dust	Effective	De Ong and White (26) in 1924
Philopteridae			
Goniocotes gigas Tasch. (large chicken louse)	Powder + inert (1+4) as a dust	Effective	Calif. Agr. Expt. Sta. (16) in 1923
Ditto	Powder + $CaCO_3$ (1+4) as a dust	Effective	De Ong and White (26) in 1924
Lipeurus heterographus Nitzsch (chicken head louse)	Powder as a dust	Effective	Brittain (13) in 1924
Ditto	Powder + vaseline (1+3)	Effective	Ditto

Insect and Stage	Preparation	Effectiveness	Reference
Mallophaga (cont.)			
Philopteridae (cont.)			
Lipeurus heterographus Nitzsch (chicken head louse)	Powder in water (1:1280)	Effective	Brittain (13) in 1924
Ditto	Powder and tobacco dust (1+4) as a dust	Effective	Gilmer (44) in 1923
Trichodectidae			
Bovicola bovis L.	Powder as a dust	Effective	Wells, Bishopp and Laake (109 in 1922
Ditto	Powder + flour (1+1) as a dust	Effective	Ditto
Ditto	Powder + Kaf (1+1) as a dust	Effective	Ditto
Ditto	Powder + tobacco (1+1) as a dust	Effective	Ditto
Thysanoptera			
Thripidae			
Heliothrips haemorrhoidalis Bouche (greenhouse thrips)	Com'l extracts (?)	Recommended	Metcalf and Flint (68) in 1928
Homoptera			
Aphiidae			
Aphids	Com'l extract (?)	Recommended	Ditto
Aphids	Powder in water (1:4000)	Effective	Carlos (17) in 1926
Aphids	Fresh root sap	Effective	Deli Proefsta. (22) in 1926
Aphids	Powder as a dust	100% kill	De Ong and White (26) in 1924

Insect and Stage	Preparation	Effectiveness	Reference
Homoptera (cont.)			
Aphiidae			
Aphids, many species	Extract	Effective	McIndoo and Sievers (65) in 1924
Aphids (black lice) on chestnut trees	Com'l extract in water (1:3000)	Effective	Anon. (3) in 1927
Aphids on a cut-leaf birch	Powder in water (1:666)	Effective in 48 hrs.	Kelsall et al. (54) in 1936
Aphids on rosebush	Com'l extract in water (1:3000)	Effective	Anon. (3) in 1927
Aphids on tobacco	Fresh or dried root decoction in water (1:100) + soap (1:320)	Effective	Bourcart (9) in 1925
Ditto	Fresh root sap	Effective	Deli Proefsta. (23) in 1927
Ditto	Fresh root in water (1:100) + soap (1:200)	Recommended	Fulmek (35) in 1924
Ditto	Fresh root in water (1:100) + soap (1:333)	Effective	Fulmek (36) in 1925
Ditto	Fresh root sap	Effective	Fulmek (37) in 1927
Ditto	Fresh root in water (3 kg. in 80 liters) (1:27)	Effective	Hollrung (50) in 1923
Aphis gossypii Glover (cotton aphid) (melon aphid)	Alcoholic extract	1/8 as effective as similar cube extract	Dennis (24, 25) in 1927
Ditto	Extract in water	Effective	McIndoo, Sievers and Abbott (66) in 1919
Ditto	Powder in water	Effective	Ditto
Ditto	Powder as a dust	Effective	Ditto

Insect and Stage	Preparation	Effectiveness	Reference
Homoptera (cont.)			
Aphiidae (cont.)			
Aphis helianthi Monell	Extract in water	Effective	McIndoo, Sievers and Abbott (66) in 1919
Ditto	Powder in water	Effective	Ditto
Ditto	Powder as a dust	Effective	Ditto
Aphis medicaginis Koch (cowpea aphid)	Powder in water (1:250)	Effective	Castillo (18) in 1926
Aphis nerii Fonsc.	Com'l extract (1:500)	13% control	De Ong and White (26) in 1924
Aphis pomi Degeer (apple aphid)	Powder in water (1:400)	Effective	Kelsall et al. (54) in 1926
Ditto	Powder + hydrated lime (1+4) as a dust	Ineffective	Ditto
Ditto	Powder as a dust	Effective	McIndoo, Sievers and Abbott (66) in 1919
Ditto	Powder in water (1:1660)	Effective	Ditto
Aphis rumicis L. (bean aphid)	Powder in water	Ineffective	Durham (27) in 1926
Ditto	Extract in water (equiv. to 0.5 to 4% root)	Slow and uncertain	Fryer et al. (33) in 1923
Ditto	Fresh root	Ineffective	Gimlette (45) in 1923
Ditto	Powder in water (1:200)	100% kill, but slow	Kelsall et al. (54) in 1926
Ditto	Powder as a dust	Effective	McIndoo, Sievers and Abbott (66) in 1919

Insect and Stage	Preparation	Effectiveness	Reference
Homoptera (cont.)			
Aphiidae (cont.)			
Aphis rumicis L. (bean aphid)	Powder in water (1:3320)	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Rotenone in water (75 p.p.m.)	100% kill	Tattersfield et al. (92) in 1926
Aphis sp. A.	Powder as a dust	Effective	McIndoo and Sievers (65) in 1924
Ditto	Hot water extract	Effective	Ditto
Aphis sp. B.	Powder as a dust	Effective	Ditto
Ditto	Hot water extract	Effective	Ditto
Aphis spiraecola Patch	Extract in water (Equiv. to 1 lb. powder to 100 gals. water)	30% kill (check 20%	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Powder in water (1:830)	50% kill	Ditto
Apple aphids, various species	Com'l extract (?)	Encouraging	Mich. Agr. Expt. Sta. (69) in 1925
Capitophorus ribis L. (currant aphid)	Powder + hydrated lime (1+1) as a dust	Ineffective	Kelsall et al. (54) in 1926
Cavariella sp.	Powder in water (1:400)	Ineffective	Brittain (13) in 1924
Eriosoma lanigerum Hausm. (woolly apple aphid)	Powder in water	Ineffective	Durham (27) in 1926
Ditto	Fresh root	Ineffective	Gimlette (45) in 1923
Macrosiphoniella sanborni Gillette (black chrysanthemum aphid)	Powder as a dust	Effective	McIndoo and Sievers (65) in 1924

Insect and Stage	Preparation	Effectiveness	Reference
Homoptera (cont.)			
Aphiidae (cont.)			
Macrosiphum (Illinoia) liriodendri Monell	Extract in water	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Powder as a dust	Effective	Ditto
Macrosiphum (Illinoia) solanifolii Ashm.	Powder + Hydrated lime (2.5 + 97.5) as a dust	Effective	Kelsall et al. (54) in 1926
Ditto	Powder in water (1:200)	Effective	Ditto
Macrosiphum (Illinoia) sp.	Powder in water	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Macrosiphum sp. A.	Powder as a dust	50% kill	McIndoo and Sievers (65) in 1924
Macrosiphum sp. C.	Powder burned as a fumigant	Effective	Ditto
Mealy plum aphid	Com'l extract (1:384)	97.6% kill	Garman (38) in 1928
Myzus cerasi F. (black cherry aphid)	Derris sprays	Encouraging	Mich. Agr. Expt. Sta. (69) in 1925
Myzus persicae Sulz. (spinach aphid)	Powder burned as a fumigant	Effective	McIndoo and Sievers (65) in 1924
Ditto	Powder as a dust	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Extract in water	Effective	Ditto
Ditto	Frosh root sap	Effective	Van der Meer Mohr (67) in 1927

Insect and Stage	Preparation	Effectiveness	Reference
Homoptera (cont.)			
Aphiidae (cont.)			
Myzus persicae Sulz. (spinach aphid)	Com'l extract (1:300)	68% control	De Ong and White (26) in 1924
Red aphids on goldenrod	Powder + hydrated lime (1+1) as a dust	Ineffective	Kelsall et al. (54) in 1926
Rhopalosiphum pseudobrassicae Davis (turnip aphid)	Extract in water	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Powder as a dust	Effective	Ditto
Toxoptera aurantiae Boyer (black citrus aphid)	Com'l extracts	Effective	Symes (89) in 1924
Cicadellidae			
Empoasca maligna Walsh (apple leafhopper), young nymphs	Com'l extracts (?)	Recommended	Metcalf and Flint (68) in 1928
Empoasca fabae Harris (potato leafhopper)	Com'l extract (1:250)	Ineffective	Delong (21) in 1928
Eupteryx flavoscuta var. nigra Osb.	Com'l extract (1:800) + soap (1:200)	Effective but slow	McBride (64) in 1926
Coccidae			
Lepidosaphes ulmi L. (oystershell scale), crawling young	Powder as a dust	Ineffective	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Powder in water (1 lb. to 20 gals.)	Ineffective	Ditto
Orthezia insignis Dougl. (greenhouse orthezia)	Powder as a dust	Ineffective	Ditto
Pseudococcus citri Risso (mealybug)	Powder as a dust	Ineffective	Ditto

Insect and Stage	Preparation	Effectiveness	Reference
Homoptera (cont.)			
Psyllidae			
Chermes (jumping plant lice)	Powder as a dust	Ineffective	Kelsall et al. (54) in 1926
Psylla (jumping plant louse)	Powder in water	Effective	Carlos (17) in 1926
Hemiptera			
Cimicidae			
Cimex lectularius L. (bedbug)	Powder as a dust	24.4% kill in 24 hours. 52.8% kill in 4 days	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Powder as a dust	100% kill in 3-1/2 hours.	Kelsall et al. (54) in 1926
Coreidae			
Anasa tristis Degeer (squash bug)	Powder + hydrated lime (1+1) as a dust	Ineffective	Ditto
Miridae			
Heterocordylus malinus Reuter (dark red bug)	Powder in water	Effective	Kopp (55) in 1924
Ditto	Com'l extract (10 lb. to 100 gals.) (1:83)	Effective	Parrott, Glasgow, and McLeod, (76) in 1921
Lygidea mendax Reuter (apple red bug)	Powder in water	Effective	Kopp (55) in 1924
Ditto	Com'l extract (1:83)	Effective	Parrott, Glasgow, and McLeod, (76) in 1921
Pentatomidae			
Scotinophara coarctata F.	Extract	Uncertain	Fed. Malay States Dept. Agr. (28) in 1920

Insect and Stage	Preparation	Effectiveness	Reference
Hemiptera (cont.)			
Pentatomidae (cont.)			
Scotinophara coarctata F.	Tuba root as a spray	Effective	Corbett and Yusope (19) in 1924
Pyrrhocoridae			
Dysdercus cingulatus F. (nymphs)	Fresh root sap in water	Effective	Gater (39) in 1925
Dysdercus suturellus H. S. (cotton stainer)	Tuba mixtures as a spray	Recommended	Jack and Sands (53) in 1922
Coleoptera			
Small beetles on palms	Powder	Use suggested	Flippance (32) in 1920
Chrysomelidae			
Galerucella rubi Tamanuki	Com'l extract + soap	Recommended	Tamanuki (90) in 1928
Leptinotarsa decemlineata Say (Colorado potato beetle), adults	Powder in water (1:1600)	100% kill	Brittain (13) in 1924
Ditto (larvae)	Powder in water (1:1600)	100% kill	Ditto
Ditto (adults)	Powder as a dust	Effective	Kelsall et al. (54) in 1926
Ditto (adults)	Powder in water	Effective	Ditto
Ditto (larvae)	Powder in water (1:1000)	Effective	Kopp (55) in 1924
Ditto (adults)	Extract + soap	Ineffective	McIndoo and Sievers (65) in 1924
Ditto (larvae)	Extract + soap	Ineffective	Ditto
Ditto (larvae)	Extract in water	Effective	McIndoo, Sievers, and Abbott (66) in 1919

Insect and Stage	Preparation	Effectiveness	Reference
Coleoptera (cont.)			
Chrysomelidae (cont.)			
Leptinotarsa decemlineata Say (Colorado potato beetle), adults	Extract in water	25-29% kill	McIndoo, Sievers, and Abbott (66) in 1919
Ditto (larvae)	Powder in water	Effective	Ditto
Ditto (adults)	Powder in water	70% kill	Ditto
Ditto (larvae)	Powder as a dust	Effective	Ditto
Phaedon incertum Baly	Derris mixturos	Recommended	Nozu and Sonoyama (72) in 1926
Three-lined potato beetle	Powder + hydrated lime (1+1) as a dust	Effective	Kelsall et al. (54) in 1926
Coccinellidae			
Lady-beetle	Powder burned as a fumigant	Effective	McIndoo and Sievers (65) in 1924
Ladybird beetle larvae	Powder in water (1:666) + soap	Effective	Kelsall et al. (54) in 1926
Curculionidae			
Ceutorhynchus pleurostigma Marsh	Powder + soot (1+2) as a dust	Ineffective	K.M.Smith (85) in 1925
Lepidoptera			
Cabbage worms	Powder in water	Ineffective	Leefmans (56) in 1927
Ditto	Alcoholic extract	Effective	Ditto
Ditto	Com'l extract (1:3000)	Effective	Anon. (3) in 1927

Insect and Stage	Preparation	Effectiveness	Reference
Lepidoptera (cont.)			
Amathusiidae			
Amathusia phidippus L. (large coconut butterfly), larvae	Powder	Use suggested	Flippance (32) in 1920
Arctiidae			
Hyphantria cunea Drury (fall webworm), larvae	Powder in water	Ineffective	Brittain (13) in 1924
Ditto	Powder as a dust	Ineffective	Kelsall et al. (54) in 1926
Ditto	Powder in water (1:100)	Ineffective	Ditto
Ditto	Powder in water	Effective	Kopp (55) in 1924
Ditto	Powder burned as a fumigant	Ineffective	McIndoo and Sievers (65) in 1924
Ditto (1st instar larvae)	Extract + soap	Ineffective	Ditto
Ditto (larvae)	Powder in water (1:42)	Effective	McIndoo, Sievers and Abbott (66) in 1919
Ditto	Extract in water	Effective	Ditto
Bombycidae			
Bombyx mori L. (silkworm), larvae	Alcoholic extract in water (equiv. to 0.25% root)	Effective	Pryer et al. (33) in 1923
Ditto	Powder as a dust	Effective	McIndoo and Sievers (65) in 1924
Ditto	Powder burned as a fumigant	Effective	Ditto

Insect and Stage	Preparation	Effectiveness	Reference
Lepidoptera (cont.)			
Ceratocampidae			
Anisota senatoria A. and S. (orange-striped oak worm), larvae	Powder in water (1:200)	Effective	Kopp (55) in 1924
Ditto	Powder in water (1:200)	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Coleophoridae			
Coleophora laricella Hbn. (larch case bearer)	Powder as a dust	Partly effective	Kelsall et al. (54) in 1926
Ditto	Powder in water	Partly effective	Ditto
Geometridae			
Cingilia catenaria Drury (chain spotted geometer)	Powder as a dust	Ineffective	Ditto
Ditto	Powder in water	Ineffective	Ditto
Geometrid larvae	Powder in water (1:666) + soap	Effective	Ditto
Hesperiidae			
Erionota thrax L., larvae	Powder	Use suggested	Flippance (32) in 1920
Lasiocampidae			
Malacosoma americana F. (eastern tent caterpillar), larvae	Powder in water (1:1000)	Effective	Kelsall et al. (54) in 1926
Ditto (young larvae)	Powder in water (1:1660)	Effective	McIndoo, Sievers, and Abbott (66) in 1919

Insect and Stage	Preparation	Effectiveness	Reference
Lepidoptera (cont.)			
Lasiocampidae (cont.)			
Malacosoma americana F. (eastern tent caterpillar)	Powder as a dust	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Powder burned as a fumigant	Ineffective	McIndoo and Sievers (65) in 1924
Ditto (larvae)	Powder in water (1:1000)	Effective	Kelsall et al. (54) in 1926
Malacosoma disstria Hbn. (forest tent caterpillar)	Powder as a dust	Ineffective	Ditto
Ditto	Powder in water	Ineffective	Ditto
Malacosoma neustria L., larvae	Powder in water (1 to 50)	100% kill	Fryer et al. (33) in 1923
Malacosoma sp., larvae	Powder in water (1:1600)	Effective	Kopp (55) in 1924
Small eggar, larvae	Powder in water	Effective	Durham (27) in 1926
Limacodidae			
Parasa herbifera Wlk., mature larvae	Fresh root sap in water	Effective	Gater (39) in 1925
Lymantriidae			
Arctornis alba Bremer	Com'l extract (?) + soap	Effective	Sonan (87) in 1927
Euproctis pseudoconspersa Strand	Com'l extract (?) + soap	Effective	Ditto
Euproctis sericea Wileman	Com'l extract (?) + soap	Effective	Ditto
Hemerocampa leucostigma A. & S. (white-marked tussock moth)	Extract in water	Effective	McIndoo, Sievers, and Abbott (66) in 1919

Insect and Stage	Preparation	Effectiveness	Reference
Lepidoptera (cont.)			
Lymantriidae			
Laelia suffosa Wlk., larvae	Fresh root sap in water	Effective	Gater and Yusope (40) in 1925
Notolophus posticus Wlk.	Com'l extract (?) + soap	Effective	Sonan (87) in 1927
Olene mendosa Hbn.	Com'l extract (?) + soap	Effective	Ditto
Porthesia taiwana Shir.	Com'l extract (?) + soap	Effective	Ditto
Porthesia scintillans Wlk.	Com'l extract (?) + soap	Effective	Ditto
Pseudodura dasychiroides Strang	Com'l extract (?) + soap	Effective	Ditto
Stilpnotia cygna Moore	Com'l extract (?) + soap	Effective	Ditto
Noctuidae			
Autographa brassicae Riley (cabbage looper), larvae	Powder in water (1:200)	Effective	Kopp (55) in 1924
Ditto (larvae)	Powder in water (1:208)	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Cutworms	Powder in water	Effective	Durham (27) in 1926
Ditto	Powder in bait	Ineffective	Kelsall et al. (54) in 1926
Pelia oleracea L. (glasshouse tomato moth), larvae	Alcoholic extract in water (equiv. to 6% root)	Effective	Ditto
Ditto (larvae)	Powder in water (1:10)	Effective	Lloyd (59) in 1920

Insect and Stage	Preparation	Effectiveness	Reference
Lepidoptera (cont.)			
Noctuidae (cont.)			
Polia oleracea L. (glasshouse tomato moth), larvae	Alcoholic extract in water (1:1000)	Effective	Lloyd (59) in 1920
Prodenia litura F., larvae	Decoction of fresh root	Ineffective	De Bussy (14) in 1922
Notodontidae			
Datana ministra Drury (yellow-necked caterpillar), larvae	Powder in water (1:400)	Effective	Kopp (55) in 1924
Ditto	Powder in water (1:415)	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Drymonia manleyi Leech, older larvae	Extract + soap	Recommended	Tanaka (91) in 1927
Phalera bucephala L., larvae	Powder in water (1:50)	100% kill	Fryer et al. (33) in 1923
Nymphalidae			
Euphydryas chalcedona Dbldy. & Hew., larvae	Powder as a dust	98% kill	De Ong and White (26) in 1924
Yponomeutidae			
Yponomouta padella L.	Powder in water (1:50)	100% kill	Fryer et al. (33) in 1923
Plutellidae			
Plutella maculipennis Curt. (diamondback moth), larvae	Fresh root sap	Not entirely effective	Bange (4) in 1927
Olethreutidae			
Carpocapsa pomonella L. (codling moth)	Com'l extract	Promising	Quaintance (77) in 1928

Insect and Stage	Preparation	Effectiveness	Reference
Lepidoptera (cont.)			
Olethreutidae (cont.)			
Carpocapsa pomonella L. (codling moth)	Com'l extract + white oil emulsion in water	Effective	Quaintance (78) in 1929
Ditto	Alcoholic extract in water	Ineffective	Ditto
Ditto	Com'l extract (?) in water	Effective	Van Leeuwen (104) in 1928
Laspeyresia nigricana Stephens	Powder in water (1:50)	Effective	Miles (70) in 1925
Spilonota ocellana D. and S. (eye-spotted budmoth), larvae	Powder in water (1:500)	Ineffective	Kelsall et al. (54) in 1926
Pieridae			
Cabbage butterflies	Com'l extract (1:3000)	A repellent	Anon. (3) in 1927
Pieris brassicae L., larvae	Powder in water (1:100)	100% kill	Fryer et al. (33) in 1923
Pieris rapae L. (imported cabbage worm), larvae	Powder in water (1:400)	90% kill	Kelsall et al. (54) in 1926
Ditto	Powder + hydrated lime as a dust	Less than spray	Ditto
Pyralididae			
Diatraea auricilia Dudg.	Sap from fresh root	Effective	Jack (52) in 1923
Hellula undalis F. (cabbage webworm)	Com'l extract (?)	Recommended	Watanabe (108) in 1927
Nymphula depunctalis Guen.	Decoction	Effective	Federated Malay States (29) in 1922

Insect and Stage	Preparation	Effectiveness	Reference
Lepidoptera (cont.)			
Pyralididae (cont.)			
Nymphula depunctalis Guen.	Fresh root sap in water	Use suggested	Otanes (73) in 1925
Scheonobius bipunctiforus Wlk.	Extract	Uncertain	Federated Malay States (28) in 1920
Ditto	Sap from fresh root	Effective	Jack (52) in 1923
Tirathaba sp., larvae	Fresh root sap in water	Effective	Gater (39) in 1925
Tineidae			
Clothes moths, adults	Powder + hydrated lime (1:1) as a dust	Effective	Kelsall et al. (54) in 1926
Ditto (larvae)	Ditto	Effective	Ditto
Tinea sp., adults	Com'l extract in water (1:3000)	100% kill in 1 hour	Anon. (3) in 1927
Noctuid moths (?)	Powder in water	Effective	Kelsall et al. (51) in 1926
Hymenoptera			
Apidae			
Apis mellifera L. (honey bee)	Powder in honey (1:400)	100% kill in 24 hours	Ginsburg (46) in 1928
Ditto	Extract in honey	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Powder in honey	94% kill in 48 hours	Ditto
Pamphiliidae			
Neurotoma fasciata Norton, half-grown larvae	Extract + soap	Effective	McIndoo and Sievers (65) in 1924

Insect and Stage	Preparation	Effectiveness	Reference
Hymenoptera (cont.)			
Tenthredinidae			
European rose sawfly	Powder as a dust	Effective	Gorham (47) in 1923
Pristiphora erichsonii Htg. (larch sawfly), larvae	Powder as a dust	100% kill	Kelsall et al. (54) in 1926
Phymatocera aterrima Klug, larvae	Alcoholic extract	Effective	Fryer et al. (33) in 1923
Nematus (Pteronidea) ribesii Scopoli (imported currant worm), larvae	Powder in water	Effective	Durham (27) in 1926
Ditto	Powder in water (1:100)	100% kill	Fryer et al. (33) in 1923
Ditto	Powder in water (1:3330)	100% kill	Kelsall et al. (54) in 1926
Ditto	Powder + hydrated lime (1.25 + 98.75) as a dust	100% kill	Ditto
Ditto	Fresh root	Effective	Gimlette (45) in 1923
Rush sawfly larvae	Com'l extract (1:1000)	100% kill	Harukawa (49) in 1925
Vespidae			
Hornet	Com'l extract (1:3000)	Effective	Anon. (3) in 1927
Diptera			
Flies, undetermined species	Powder in water	Effective	Kelsall et al. (54) in 1926
Agromyzidae			
Agromyza phaseoli Coq. (French bean fly)	Fresh root sap in water (1:320)	Effective	Mathieu (62) in 1920

Insect and Stage	Preparation	Effectiveness	Reference
Diptera (cont.)			
Anthomyiidae			
Hylemya antiqua Meig. (onion maggot), young larvae	Powder in water (1:333)	100% kill	Brittain (11) in 1921
Ditto (full-grown larvae)	Powder in water	No kill	Ditto
Ditto (young larvae)	Ditto	Effective	Brittain (13) in 1924
Ditto (mature larvae)	Ditto	Ineffective	Ditto
Ditto (larvae)	Powder + soot (1+2) as a dust	Ineffective	K.M.Smith (85) in 1925
Ditto	Powder + soot (1+2) as a dust	60% clean onions	Smith and Wadsworth (86) in 1921
Hylemya brassicae Bouche (cabbage maggot)	Powder + clay (1+1) as a dust	Effective	Brittain (11) in 1921
Ditto	Powder in water (1:333)	Effective	Ditto
Ditto	Powder in water (1:333)	Ineffective	Brittain (12) in 1922
Ditto (larvae)	Powder in water (1:333)	Ineffective	Brittain (13) in 1924
Ditto	Powder + soot (1+2) as a dust	Ineffective	K.M.Smith (85) in 1925
Culicidae			
Aedes vexans Meig., larvae	Powder dusted on water (2 to 3 lbs. per acre)	Effective	Gibson (41) in 1927
Ditto (larvae)	Powder dusted on water (3 lbs. per acre)	Effective in 7 hrs.	Twinn (96) in 1927

Insect and Stage	Preparation	Effectiveness	Reference
Diptera (cont.)			
Culicidae (cont.)			
Aedes vexans Meig., larvae	Powder + French chalk (1+4) dusted on water (1-1/2 lbs. per acre)	Effective	Twinn (96) in 1927
Ditto (pupae)	Powder dusted on water (3 lbs. per acre)	Effective in 24 hours	Ditto
Aedes sp., larvae	Powder dusted on water (15 lbs. per acre)	Effective in 22 hours	Gibson (43) in 1928
Ditto (pupae)	Ditto	Effective in 2 to 5 days	Ditto
Culex pipiens L. (northern house mosquito), larvae	Powder dusted on water (30 lbs per acre)	100% kill in 72 hours	Ditto
Ditto (larvae)	Powder in water (1:10,000)	Effective	Gimlette (45) in 1923
Ditto (pupae)	Ditto	Effective	Ditto
Mosquito larvae	Powder in water (1:333)	Effective	Castillo (18) in 1926
Ditto	Powder in water	Effective	Durham (27) in 1926
Ditto	Powder in water (1:1000)	100% kill in 3 to 4 days	Kelsall et al. (54) in 1926
Ditto	Com'l extract (1:500)	65% kill	De Ong and White (26) in 1924
Ditto	Powder	90% kill	Ditto
Mosquito pupae	Powder in water	Effective but slow	Durham (27) in 1926
Ditto	Com'l extract (1:500)	Ineffective	De Ong and White (26) in 1924

Insect and Stage	Preparation	Effectiveness	Reference
Diptera (cont.)			
Culicidae (cont.)			
Theobaldia annulata Schrank, larvae	Powder in water (1:40,000)	Effective	Gimlette (45) in 1923
Ditto (pupae)	Powder in water (1:10,000)	Effective	Ditto
Muscidae			
Cochliomyia sp. (screwworms), adults	Powder as a dust	A repellent	Parman et al. (75) in 1928
Ditto	Powder + kaolin (1+9) on bait	A repellent	Ditto
Ditto	Powder as a dust	A repellent	Roark et al. (83) in 1927
Lucilia sp. (green bottle fly), adults	Powder + kaolin (1:9)	A repellent	Parman et al (75) in 1928
Musca domestica L. (housefly)	Powder as a dust	Ineffective in 24 hours	Kelsall et al. (54) in 1926
Ditto	Powder in water (1:200)	100% kill in 48 hours	Ditto
Ditto	Powder as a dust	100% kill in 16 hours	McIndoo, Sievers, and Abbott (66) in 1919
Mycetophilidae			
Sciara praecox Meig. (mushroom fly)	Powder as a dust	Effective	Symes (88) in 1921
Oestridae			
Hypoderma larvae	Powder in water	Effective	Bishopp, Laake, and Wells (7) in 1922
Ditto	Powder	Recommended	Leynen (58) in 1928
Ditto	Derris wash	Recommended	Metcalf and Flint (68) in 1928

Insect and Stage	Preparation	Effectiveness	Reference
Diptera (cont.)			
Oestridae (cont.)			
Hypoderma larvae	Powder in water (1:20)	94% kill	MacDougall (59, 60) in 1924
Ditto	Powder in water (1:8.3) + soap (1:33.2)	Effective	U. S. Dept. Agr. (100) in 1923
Ditto	Powder + vaseline (1+5)	Effective	Ditto
Ditto	Powder as a dust	Effective	U. S. Dept. Agr. (102) in 1927
Ditto	Powder + vaseline (1+2) applied to holes	Effective	Walton (106) in 1925
Ditto	Powder + soft paraffin (1+2)	Effective	Walton (107) in 1927
Ditto	Powder + soft paraffin + olive oil (1+1+1)	Effective	Ditto
Ditto	Powder + vaseline (1+2) applied to holes	Effective	Wells, Bishopp, and Laake (109) in 1922
Ditto	Powder + soap in water (1:8.3) + soap (1:33.2)	Effective	Ditto
Hypoderma bovis Degeer (northern cattle grub)	Com'l extract (1:10)	Effective	Bishopp et al. (6) in 1926
Ditto	Powder in water (1:16.6) + soap (1:33.2)	Effective	Ditto
Ditto	Powder as a dust	Effective	Ditto
Ditto	Powder + petrolatum	Effective	Ditto

Insect and Stage	Preparation	Effectiveness	Reference
Diptera (cont.)			
Oestridae (cont.)			
Hypoderma bovis Degeer (northern cattle grub)	Powder + paraffin oil	Effective	Bishopp et al. (6) in 1926
Hypoderma lineatum DeVill. (common cattle grub)	Com'l extract (1:10)	Effective	Ditto
Ditto	Powder in water (1:16.6) + soap (1:33.2)	Effective	Ditto
Ditto	Powder as a dust	Effective	Ditto
Ditto	Powder + petrolatum	Effective	Ditto
Ditto	Powder + paraffin oil	Effective	Ditto
Psilidae			
Psila rosae F. (carrot rust fly)	Powder as a dust	Considerable control	Kelsall et al. (54) in 1926
Ditto	Powder in water	Ditto	Ditto
Ditto	Powder + soot (1+2) as a dust	95% clean carrots	Smith and Wadsworth (86) in 1921
Ditto	Ditto	Ineffective	K.M.Smith (85) in 1925
Syrphidae			
Syrphid fly larvae	Powder in water (1:666) + soap	Effective	Kelsall et al. (54) in 1926
Tipulidae			
Leatherjackets	Powder + bran (1 lb. + 20 lbs. per acre) as a poison bait	Moderately effective	Thompson (93) in 1928

Insect and Stage	Preparation	Effectiveness	Reference
Unclassified Insects			
Maize stalk borer	Powder in water (1:90)	Effective	Ripley and Hepburn (80) in 1928
Ditto	Powder as a dust (1:12)	Less effective than above	Ditto
Mites causing curly-leaf	Com'l extract in water (1:3000)	Effective	Anon. (3) in 1927
Rice borer, larvae	Fresh root sap in water	Effective	Otanes (73) in 1925
Acarina			
Gamasidae			
Dermanyssus gallinae Degeer (chicken mite)	Powder as a dust	Effective	Davidson (20) in 1924
Ditto	Powder + flour (1+1) as a dust	Ineffective	Ditto
Ditto	Com'l extract in water (1:500)	Ineffective	Ditto
Ditto (in jars)	Powder as a dust	100% kill in 24 hours	McIndoo, Sievers, and Abbott (66) in 1919
Ditto (in chicken house)	Powder as a dust	Kill incomplete	Ditto
Tetranychidae			
Tetranychus telarius L. (red spiders)	Powder in water	Effective	Carlos (17) in 1926
Ditto	Com'l extract (1:300)	25% control	De Ong and White (26) in 1924
Ditto	Powder as a dust	Ineffective	McIndoo, Sievers, and Abbott (66) in 1919

Insect and Stage	Preparation	Effectiveness	Reference
Unclassified Insects (cont.)			
Siphonaptera			
Fleas on animals	Com'l extract (?)	Recommended	Metcalf and Flint (68) in 1928
Ditto	Powder as a dust	Recommended	Ditto
Fleas on rabbit	Powder as a dust	Recommended	Schwartz and Shook (84) in 1928
Dolichopsyllidae			
Nosopsyllus fasciatus Bosc. (rat flea)	Powder + tobacco dust (1+4) as a dust	Effective	Gilmer (44) in 1923
Pulicidae			
Ctenocephalides canis Curt. (dog flea)	Fresh root sap in water	Effective	Anon. (2) in 1926
Ditto	Powder + tobacco dust (1+4) as a dust	Effective	Gilmer (44) in 1923
Ditto	Powder as a dust	Effective	McIndoo and Sievers (65) in 1924
Ditto	Powder as a dsut	Effective	McIndoo, Sievers, and Abbott (66) in 1919
Ditto	Powder + corn-starch (1+3) as a dust	Effective	Wells, Bishopp, and Laake (109) in 1922
Ditto	Powder + flour or cornstarch (1+2) as a dust	Effective	Bishopp (5) in 1926

Insect and Stage	Preparation	Effectiveness	Reference
Siphonaptera (cont.)			
Pulicidae			
Ctenocephalides felis Bouche (cat flea)	Powder + tobacco dust (1+4) as a dust	Effective	Gilmer (44) in 1925
Ditto	Powder + corn-starch (1+3) as a dust	Effective	Wells, Bishopp, and Laake (109) in 1922
Ditto	Powder + flour or cornstarch (1+2) as a dust	Effective	Bishopp (5) in 1926
Sarcopsyllidae			
Echidnophaga gallinacea Westw. (sticktight flea)	Powder as a dust	Effective	Wells, Bishopp, and Laake (109) in 1922
Anoplura			
Lice on animals	Com'l extract (?)	Recommended	Metcalf and Flint (68) in 1928
Lice on cattle and horses	Powder + dry cement powder as a dust	Effective	Kelsall et al. (54) in 1926
Lice on sheep	Powder as a dust	Recommended	Metcalf and Flint (68) in 1928
Haematopinidae			
Linognathus piliferus Burm.	Powder + corn-starch (1+3) as a dust	Effective	Wells, Bishopp, and Laake(109) in 1922
Ditto	Powder + flour (1+1) as a dust	Effective	Ditto
Linognathus vituli L.	Powder as a dust	Effective	Ditto
Ditto	Powder + flour (1+1) as a dust	Effective	Ditto

Insect and Stage	Preparation	Effectiveness	Reference
Anoplura (cont.)			
Haematopinidae (cont.)			
Linognathus vituli L.	Powder + NaF (1+1) as a dust	Effective	Wells, Bishopp, and Laake (109) in 1922
Polyplax spinulosus Burm. (rat louse)	Powder + tobacco dust (1+4) as a dust	Effective	Gilmer (44) in 1923
Ditto	Powder + tobacco dust + sulphur (7.5 + 67.5 + 25) as a dust	Effective	Ditto
Solenopotes capillatus End.	Powder + flour (1+1) as a dust	Effective	Wells, Bishopp, and Laake (109) in 1922

Table 2.--Alphabetical list of insect species mentioned in this paper, together with their common names and classification

Insect	Common Name	Order	Family
Aedes vexans Meig.		Diptera	Culicidae
Aedes sp.		Diptera	Culicidae
Agromyza phaseoli Coq.	French bean fly	Diptera	Agromyzidae
Amathusia phidippus L.	large coconut butterfly	Lepidoptera	Amathusiidae
Anasa tristis DeGeer	squash bug	Hemiptera	Coreidae
Anisota senatoria A. & S.	orange-striped oak worm	Lepidoptera	Ceratocampidae
Aphis gossypii Glover	cotton aphid, melon aphid	Homoptera	Aphiidae
Aphis helianthi Monell		Homoptera	Aphiidae
Aphis medicaginis Koch	cowpea aphid	Homoptera	Aphiidae
Aphis nerii Fonsc.		Homoptera	Aphiidae
Aphis pomi DeGeer	apple aphid	Homoptera	Aphiidae
Aphis rumicis L.	bean aphid	Homoptera	Aphiidae
Aphis sp. A.		Homoptera	Aphiidae
Aphis sp. B		Homoptera	Aphiidae
Aphis spiraecola Patch		Homoptera	Aphiidae
Apis mellifera L.	honey bee	Hymenoptera	Apidae
Arctornis alba Bremer		Lepidoptera	Lymantriidae
Autographa brassicae Riley	cabbage looper	Lepidoptera	Noctuidae
Blattella germanica L.	German cockroach	Orthoptera	Blattidae
Bombyx mori L.	silkworm	Lepidoptera	Bombycidae
Bovicola bovis L.		Mallophaga	Trichodectidae
Capitophorus ribis L.	currant aphid	Homoptera	Aphiidae
Carpocapsa pomonella L.	codling moth	Lepidoptera	Olethreutidae
Cavariella sp.		Homoptera	Aphiidae
Ceutorhynchus pleurostigma Marsh.		Coleoptera	Curculionidae
Chermes	jumping plant lice	Homoptera	Psyllidae
Cimex lectularius L.	bedbug	Hemiptera	Cimicidae
Cingilia catenaria Drury	chain spotted geometer	Lepidoptera	Geometridae
Cochliomyia sp.	Screwworms	Diptera	Muscidae
Coleophora laricella Hbn.	larch case bearer	Lepidoptera	Coleophoridae
Ctenocephalides canis Curt	dog flea	Siphonaptera	Pulicidae
Ctenocephalides felis Bouche	cat flea	Siphonaptera	Pulicidae
Culex pipiens L.	northern house mosquito	Diptera	Culicidae
Datana ministra Drury	yellow-necked caterpillar	Lepidoptera	Notodontidae
Dermanyssus gallinae DeGeer	chicken mite	Acarina	Gamasidae
Diatraea auricilia Dudg.		Lepidoptera	Pyralididae
Drymonia manleyi Leech		Lepidoptera	Notodontidae
Dysdercus suturellus H.S.	cotton stainer	Hemiptera	Pyrrhocoridae
Dysdercus cingulatus F.		Hemiptera	Pyrrhocoridae

Insect	Common Name	Order	Family
Echidnophaga gallinacea Westw.	sticktight flea	Siphonaptera	Sarcopsyllidae
Empoasca maligna Walsh	apple leafhopper	Homoptera	Cicadellidae
Empoasca fabae Harris	potato leafhopper	Homoptera	Cicadellidae
Erionota thrax L.		Lepidoptera	Hesperiidae
Eriosoma lanigerum Hausm.	woolly apple aphid	Homoptera	Aphiidae
Euphydryas chalcedona Dbldy. & Hew.		Lepidoptera	Nymphalidae
Euproctis pseudoconspersa Strand		Lepidoptera	Lymantriidae
Euproctis sericea Wileman		Lepidoptera	Lymantriidae
Eupteryx flavescuta var. nigra Osb.		Homoptera	Cicadellidae
Galerucella rubi Tamanuki		Coleoptera	Chrysomelidae
Geometrid larvae		Lepidoptera	Geometridae
Gliricola porcelli L.		Mallophaga	Gyropidae
Goniocotes gigas Tasch.	large chicken louse	Mallophaga	Philopteridae
Gryllotalpa sp.	mole cricket	Orthoptera	Gryllidae
Gyropus ovalis Nitzsch		Mallophaga	Gyropidae
Heliothrips haemorrhoidalis Bouche'	Greenhouse thrips	Thysanoptera	Thripidae
Hellula undalis F.	Cabbage webworm	Lepidoptera	Pyralididae
Hemerocampa leucostigma A. & S.	white-marked tussock moth	Lepidoptera	Lymantriidae
Heterocordylus malinus Reuter	dark red bug	Hemipitera	Miridae
Hylemya antiqua Meig.	onion maggot	Diptera	Anthomyiidae
Hylemya brassicae Bouche'	cabbage maggot	Diptera	Anthomyiidae
Hyphantria cunea Drury	fall webworm	Lepidoptera	Arctiidae
Hypoderma larvae		Diptera	Oestridae
Hypoderma lineatum Devill.	common cattle grub	Diptera	Oestridae
Hypoderma bovis DeGeer	northern cattle grub	Diptera	Oestridae
Laelia suffosa Walk.		Lepidoptera	Lymantriidae
Laspeyresia nigricana Stephens		Lepidoptera	Olethreutidae
Lepidosaphes ulmi L.	oystershell scale	Homoptera	Coccidae
Leptinotarsa decemlineata Say	Colorado potato beetle	Coleoptera	Chrysomelidae
Linognathus piliperus Burm.		Anoplura	Haematopinidae
Linognathus vituli L.		Anoplura	Haematopinidae
Lipeurus heterographus Nitzsch	chicken head louse	Mallophaga	Philopteridae
Lucilia sp.	Green bottle fly	Diptera	Muscidae
Lygidea mendax Reuter	apple red bug	Hemiptera	Miridae
Macrosiphoniella sanborni Gillette	chrysanthemum aphid	Homoptera	Aphiidae

Insect	Common Name	Order	Family
Macrosiphum (Illinoia) liriodendri Mon.		Homoptera	Aphiidae
Macrosiphum (Illinoia) sp.		Homoptera	Aphiidae
Macrosiphum (Illinoia) solanifolii Ashm.		Homoptera	Aphiidae
Macrosiphum sp. A.		Homoptera	Aphiidae
Macrosiphum sp. C		Homoptera	Aphiidae
Malacosoma americana F.	eastern tent caterpillar	Lepidoptera	Lasiocampidae
Malacosoma disstria Hbn.	forest tent caterpillar	Lepidoptera	Lasiocampidae
Malacosoma neustria L.		Lepidoptera	Lasiocampidae
Malacosoma sp.		Lepidoptera	Lasiocampidae
Mallophaga on chickens		Mallophaga	
Menopon biseriatum Piaget		Mallophaga	Menoponidae
Musca domestica L.	housefly	Diptera	Muscidae
Myzus cerasi F.	black cherry aphid	Homoptera	Aphiidae
Myzus persicae Sulz.	spinach aphid	Homoptera	Aphiidae
Nematus (Pteronidea) ribessii Scopoli	imported currant worm	Hymenoptera	Tenthredinidae
Neurotoma fasciata Norton		Hymenoptera	Pamphiliidae
Noctuid moths		Lepidoptera	
Nosopsyllus fasciatus Bosc.	rat flea	Siphonaptera	Dolichopsyllidae
Notolophus posticus Wlk.		Lepidoptera	Lymantriidae
Nymphula depunctalis Guen.		Lepidoptera	Pyralididae
Olene mendosa Hbn.		Lepidoptera	Lymantriidae
Orthezia insignis Dougl.	greenhouse orthezia	Homoptera	Coccidae
Parasa herbifera Wlk.		Lepidoptera	Limacodidae
Periplaneta americana L.	American cockroach	Orthoptera	Blattidae
Phaedon incertum Baly		Coleoptera	Chrysomelidae
Phalera bucephala L.		Lepidoptera	Notodontidae
Phymatocera aterrima Klug		Hymenoptera	Tentredinidae
Pieris brassicae L.		Lepidoptera	Pieridae
Pieris rapae L.	imported cabbage worm	Lepidoptera	Pieridae
Plutella maculipennis Curt.	diamondback moth	Lepidoptera	Plutellidae
Polia oleracea L.	glasshouse tomato moth	Lepidoptera	Noctuidae
Polyplax spinulosus Burm.	rat louse	Anoplura	Haematopinidae
Porthesia taiwana Shir.		Lepidoptera	Lymantriidae
Porthesia scintillans Wlk.		Lepidoptera	Lymantriidae
Pristiphora erichsonii Htg.	larch sawfly	Hymenoptera	Tenthredinidae
Prodenia litura F.		Lepidoptera	Noctuidae
Pseudococcus citri Risso	citrus mealybug	Homoptera	Coccidae
Pseudodura dasychiroides Strand		Lepidoptera	Lymantriidae
Psila rosae F.	carrot rust fly	Diptera	Psilidae
Psylla	jumping plant louse	Homoptera	Psyllidae
Rhopalosiphum pseudobrassicae Davis	turnip aphid	Homoptera	Aphiidae
Schoenobius bipunctiferus Wlk.		Lepidoptera	Pyralididae
Sciara praecox Meig.	mushroom fly	Diptera	Mycetophilidae
Scotinophara coarctata F.		Hemiptera	Pentatomidae
Solenopotes capillatus End.		Anoplura	Haematopinidae

Insect	Common Name	Order	Family
Spilonota ocellana D. and S.	eye-spotted budmoth	Lepidoptera	Olethreutidae
Stilpnotia cygna Moore		Lepidoptera	Lymantriidae
Tetranychus telarius L.	common red spider	Acarina	Tetranychidae
Theobaldia annulata Schrank		Diptera	Culicidae
Tinea sp.		Lepidoptera	Tineidae
Tirathaba sp.		Lepidoptera	Pyralididae
Toxoptera aurantiae Boyer	black citrus aphid	Homoptera	Aphiidae
Yponomeuta padella L.		Lepidoptera	Noctuidae

Table 3.--Alphabetical list of the common names of insects mentioned in this paper, together with their corresponding scientific names

Common Name	Scientific Name
American cockroach	Periplaneta americana L.
Apple aphid	Aphis pomi DeGeer
Apple leafhopper	Empoasca maligna Walsh
Apple red bug	Lygidea mendax Reuter
Bean aphid	Aphis rumicis L.
Bedbug	Cimex lectularius L.
Black cherry aphid	Myzus cerasi F.
Black chrysanthemum aphid	Macrosiphoniella sanborni Gillette
Black citrus aphid	Toxoptera aurantiae Boyer
Cabbage looper	Autographa brassicae Riley
Cabbage maggot	Hylemya brassicae Bouche'
Cabbage webworm	Hellula undalis F.
Carrot fly	Psila rosae F.
Carrot rust fly	Psila rosae F.
Cat flea	Ctenocephalides felis Bouche
Chain spotted geometer	Cingilia catenaria Drury
Chicken head louse	Lipeurus heterographus Nitzsch
Chicken mite	Dermanyssus gallinae DeGeer
Chrysanthemum aphid	Macrosiphoniella sanborni Gillette
Citrus mealybug	Pseudococcus citri Risso
Codling moth	Carpocapsa pomonella L.
Colorado potato beetle	Leptinotarsa decemlineata Say
Common cattle grub	Hypoderma lineatum DeVill.
Common red spider	Tetranychus telarius L.
Cotton aphid	Aphis gossypii Glover
Cotton stainer	Dysdercus suturellus H. S.
Cowpea aphid	Aphis medicaginis Koch
Currant aphid	Capitophorus ribis L.
Dark red bug	Heterocordylus malinus Reuter
Diamondback moth	Plutella maculipennis Curt.
Dog flea	Ctenocephalides canis Curt.
Eastern tent caterpillar	Malacosoma americana F.
Eye-spotted budmoth	Spilonota ocellana D. and S.
Fall webworm	Hyphantria cunea Drury
Forest tent caterpillar	Malacosoma disstria Hbn.
German cockroach	Blattella germanica L.
Glasshouse tomato moth	Polia oleracea L.

Common Name	Scientific Name
Gooseberry sawfly	Nematus (Pteronidea) ribesii Scopoli
Green bottle fly	Lucilia sp.
Greenhouse orthezia	Orthezia insignis Dougl.
Greenhouse thrips	Heliothrips haemorrhoidalis Bouché
Honey bee	Apis mellifera L.
Housefly	Musca domestica L.
Imported cabbage worm	Pieris rapae L.
Imported currant worm	Nematus (Pteronidea) ribesii Scopoli
Jumping plant lice	Chermes
Jumping plant louse	Psylla
Large chicken louse	Goniocotes gigas Tasch.
Large coconut butterfly	Amathusia phidippus L.
Larch case bearer	Coleophora laricella Hbn.
Larch sawfly	Pristiphora erichsonii Htg.
Melon aphid	Aphis gossypii Glover
Mole cricket	Gryllotalpa sp.
Mushroom fly	Sciara praecox Meig.
Northern cattle grub	Hypoderma bovis DeGeer.
Northern house mosquito	Culex pipiens L.
Onion maggot	Hylemya antiqua Meig.
Orange-striped oak worm	Anisota senatoria A. & S.
Oystershell scale	Lepidosaphes ulmi L.
Potato leafhopper	Empoasca fabae Harris
Rat flea	Nosopsyllus fasciatus Bosc.
Rat louse	Polyplax spinulosus Burm.
Screwworms	Cochliomyia sp.
Silkworm	Bombyx mori L.
Spinach aphid	Myzus persicae Sulz.
Squash bug	Anasa tristis DeGeer
Sticktight flea	Echidnophaga gallinacea Westw.
Turnip aphid	Rhopalosiphum pseudobrassicae Davis
White-marked tussock moth	Hemerocampa leucostigma A. & S.
Woolly apple aphid	Eriosoma lanigerum Hausm.
Yellow-necked caterpillar	Datana ministra Drury

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